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The Distribution of Fishes in Selected Streams on the Apache-Sitgreaves National Forest

COMPLETION REPORT

TO

UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

APACHE-SITGREAVES NATIONAL FOREST

SPRINGERVILLE, ARIZONA 85938

for

THE DISTRIBUTION OF FISHES IN SELECTED STREAMS

on the

APACHE-SITGREAVES NATIONAL FOREST

Submitted by:

FISHERIES MANAGEMENT DIVISION

ARIZONA GAME AND FISH DEPARTMENT

2222 WEST GREENWAY ROAD

PHOENIX, ARIZONA 85023

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Introduction

Man's impact on the fauna and flora of Arizona is only of recent becoming understood, prior to the rapid population expansion of the 1960's the State had adequate fish and wildlife resources to provide for the demands of users. However, with ever-increasing utilization of these resources we now recognize, or attempt to, the limitations being placed on a unique biota by the advancement of civilization. This impact is most fully understood in the terrestrial communities, less apparent is the influence civilization has placed on complex aquatic communities. Congressional legislation has addressed the problems inherent in the protection of these unique renewable resources in numerous fashions during the past decade, and at present, yet basic elements of knowledge at this time are still lacking to adequately respond to these mandates.

Although many investigators have expended considerable effort over the previous 125 years, a comprehensive faunal distribution of the fishery resource of Arizona remains at present grossly incomplete. This lack of basic data should not be inferred as belittling the noted efforts of present and past investigators who have made significant contributions toward this understanding, moreover, this factor reveals the magnitude of effort that must yet be expended to fully comprehend this resource. Newly generated data reveals that the State has in excess of 475 individual perennial waters, yet at present only approximately one-half of these have been even singularly sampled (Unpubl. data Arizona Game and Fish Department). Consequently, in an era of resource demand, a complete understanding of faunal distribution is of paramount importance for scientists, administrators, managers, and laymen to comprehend the impacts of an encroaching civilization on aquatic communities and their biota.

In an effort to alleviate these voids in basic data the cooperative effort reported herein was undertaken by the U.S.D.A., Apache-Sitgreaves National Forest and Arizona Game and Fish Department in 1976. Primary object of this study was to define existing and potential habitats of the native Arizona trout, Salmo apache, however, results of the study have yielded data beyond this scope and are presented herein.

Four discrete study areas were selected for investigation under this effort, Figure I. Each area contains one or more perennial waters having either unknown populations or known introduced populations of native fishes of undetermined status. In addition, surveys were conducted on systems suspected of having perennial flow, but not verified. In all, eighteen streams totaling in excess of 241 kilometers (150 miles) were inventoried in the Black, Little Colorado and Blue River drainages during this investigation.

Methods

Sampling zones were arbitrarily selected in the laboratory for each stream prior to initiating field investigations in an effort to eliminate survey bias. Final selection of station was made in the field within the predetermined zone if perennial flow was present. This procedure resulted in a near-uniform distribution of sampling localities throughout each system. Upon establishment of a station the specific location was noted on U.S. Geological Survey quadrangles and was narratively identified by Township, Range, Section and ¼¼¼ quadrate, further, the location is given in stream kilometers (SK) above confluence for all systems in an attempt to establish documentation for future repeatability. Township surveys are incomplete in the Blue River study area. As a result, locator descriptions have been approximated by extension of existing surveys as indicated on figures accompanying the text for respective systems. Uniformity of station size was not considered requisite for this study as the primary function was qualitative rather than quantitative analyses. Station sizes varied from 25-50 meters except in areas where less habitat was available, in these instances sampling was conducted throughout the reach and was considered to be a station.

Each system was visually surveyed in its entirety either by vehicle, horseback or on foot to determine length and location of perennial flow. In addition, location of existing barriers or sites for construction of a barrier were noted during this survey. Where present, stream improvement structures were inspected to determine effectiveness and were adjudged either functional or non-functional.

Basic chemical parameters of dissolved oxygen, and hydrogen ion concentration (pH) were taken in the field at selected stations within each system using a Hach, Model AL-36B field test kit. Temperatures were recorded in degrees Celcius using a mercury pocket thermometer. Discharges presented herein were computed by standard width, depth, velocity formulae and are presented in both metric and english equivalent. Additional physical data calculated in the laboratory for each system include drainage area; calculated by planimetric measurement, and altitudinal range and gradient for the watershed and stream respectively through direct map intrepretation.

The benthic faunal community was qualitatively analyzed in each of the selected streams, since the objective was taxonomic identification of benthic invertebrates many of the difficulties encountered in quantitative studies were alleviated. However, the task of collecting all organisms within a stream ecosystem presented other problems. Many aquatic insects exhibit seasonal cycles (Hynes 1970) and may be represented in the egg state when only one sampling period is conducted.

Also, all microhabitats would have to be included in the sampling areas in order to accumulate all the different animals present at that time. The feasibility of this is at best dubious, as a result a modified sampling procedure was employed to collect the widest variety of the commoner benthic animals.

Benthos was sampled with a Surber-type square foot (929^2 cm.) sampler having a mesh containing 1,024 micron openings. This device was utilized for initial entrapment of organisms and a portable holding facility while sampling as many microhabitats as possible. Samples were taken along the bank and mid-stream (Lagler, 1956). Rocks were cleaned in the mouth of the sampler allowing the current to carry invertebrates into the posterior catchment region. The substrate was hand dredged to a depth of approximately twelve centimeters in order to dislodge burrowing animals. A modified kick-drift method resulted from foraging for additional substrates to sample while upstream from the sampler. This procedure was repeated in both pool and riffle habitats over all available substrates throughout the sampling station. It has been shown that only two or three samples will contain at least one specimen of the more common species (Hynes, 1970). These combined methods and repetitions constitute considerably more than the minimum requirements for an accurate appraisal of the commoner components of the benthic community.

Field specimens were preserved in 10 percent formalin and later transferred to a 40 percent alcohol solution for ease of sorting in the laboratory using compound microscope. Identifications were made to the family level using keys by Edmondon (1959), Pennak (1953), Usinger (1956), and Borror, DeLong and Triplehorn (1976). Final taxonomic classifications were taken from Edmondson (1959).

Fish collections were made in all systems where an icthyofauna was present. Electrofishing techniques were utilized throughout the study employing both 115 A.C. and 12 volt D.C. powered equipment. Representative samples of each collection were retained as voucher specimens for all collections except as noted herein to document and verify species occurrence. Specimens were preserved in the field using a 10 percent formalin solution and returned to the laboratory for analyses.

Where present, all available habitat types were sampled to increase probability of capture on both riffle and pool inhabiting species. All collections were analyzed for size-age structure to determine relative viability of each species population.

Upon completion of analyses all specimens were deposited in the Arizona State University Collection of Fishes for retention and use by other individuals. Catalog numbers for those collections of probable scientific interst are noted within the text. Common and scientific nomenclature of fishes utilized herein follow Minckley (1973).

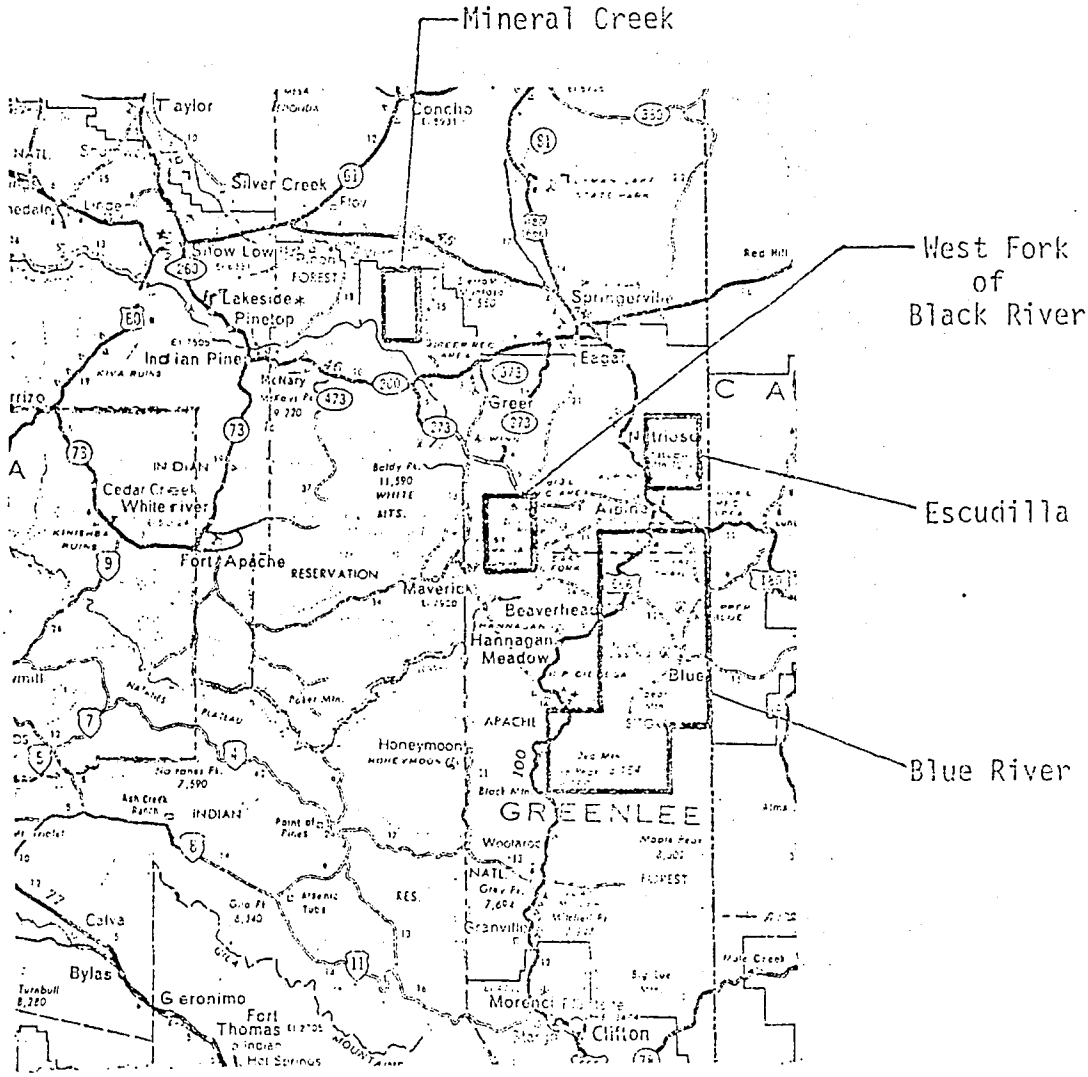


Figure I - Survey Areas On The Apache-Sitgreaves National Forest

Home Creek

Home Creek is a 15.08 kilometer (9.38 mile) south-flowing tributary of the West Fork of Black River confluence (SK 0.00) is located in NE¼NE¼NE¼, Section 10, T4NR28E, ca. 2.3 kilometers upstream from the confluence of East and West Forks of Black River. Drainage area of the system is 28.8^2 kilometers (11.1^2 miles), ranging in elevation from 2301 meters (7550 ft.) at confluence to a maximum 2870 meters (9415 ft.) on Big Lake Knoll. Mean gradient of the system is 37.7 meters/kilometer (198.8 ft./mile) over the stream course.

Home Creek was surveyed on November 18, 1976, five sampling stations were established, Table 1. Perennial flow was confined to four discrete reaches of the system, totaling 3.80 kilometers (2.36 miles), Figure II. Surface discharges calculated for Stations I and III were .80 L/sec. (12.6 gpm) and 1.7 L/sec. (26.5 gpm) respectively. These data reflect late fall figures for the system and may not be indicative of year long means as substantial quantities of potential discharge were snow and ice bound on higher elevations of the drainage area. Home Creek exhibited thermal qualities adequate for salmonid species with temperatures ranging from a high of 12^{o}C (53.6^{o} F) at Station I to 8^{o} C (46.4^{o} F) at Stations IV and V. Intermediate temperatures were observed at Stations II and III. Chemical parameters recorded at Station I were; Oxygen, 9ppm and pH 7.0.

Table I - Home Creek Sampling Station Locations, November 18, 1976

Station I----	NE¼NE¼NE¼, Sec. 10, T4NR28E:	SK 0.10(sm 0.06)
Station II---	SE¼SW¼SE¼, Sec. 28, T5NR28E;	SK 3.57(sm 2.22)
Station III--	NE¼NW¼SE¼, Sec. 28, T5NR28E;	SK 4.43(sm 2.75)
Station IV---	SW¼NE¼NW¼, Sec. 21, T5NR28E;	SK 6.74(sm 4.19)
Station V----	SW¼NW¼SE¼, Sec. 17, T5NR28E,	SK 8.50(sm 5.28)

No effective vertical barrier exists in Home Creek. However, the 2.90 kilometer (1.80 mile) dry reach of stream SK 0.13-3.03 apparently precludes upstream migration of fishes from West Fork of Black River as no collection of species found in the confluence area were made above Station I. In addition, a diversion structure located at SK 1.41 (sm 0.88) withdraws flow entering this reach, further maintaining continunity of the dry section of stream course.

An economically feasible barrier construction site does not exist in Home Creek. Due to the small amount of habitat available this system should not warrant a high priority for improvement expenditure. Existing improvement structures (log dams) are located between Stations II and III. Maximum depth of pool habitat created by functioning structures did not exceed 15 cm., while others were totally ineffective, flows either percolated through or under the structures. Consequently, due to minimal flow these devices are of marginal or no value at flows observed during this survey.

Benthic faunal diversity was extremely limited at time of survey. In collections made at Station I, Dipterans were represented only by the families Tendipedidae=Chironomidae and Heleidae=Ceratopogonidae, non-biting and biting midges respectively. Trichopteran fauna (caddisfly) was confined solely to the Hydropsychidae. These three taxa constitute the entire invertebrate faunal base observed during survey. No explanation can be given for this low diversity.

Fish fauna of Home Creek displayed low diversity with only two species collected, Table 2. The speckled dace, Rhinichthys osculus was confined to the lowermost station. This species has opportunity for invasion to and from West Fork of Black River, consequently reproduction and recruitment within Home Creek is not requisite to maintenance of this population. Size range of specimens collected indicates that the species does maintain a viable population within the lowermost perennial reach of Home Creek.

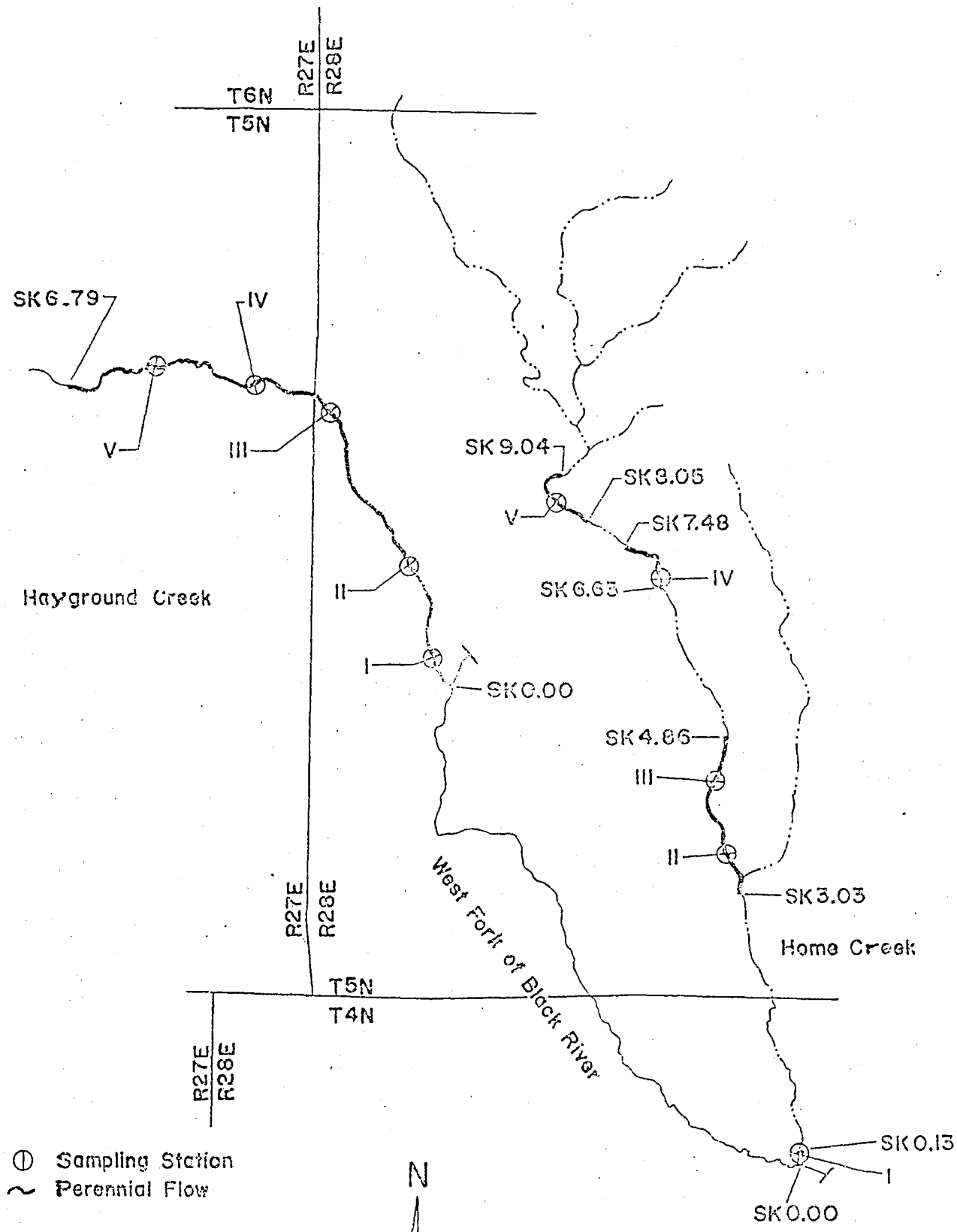
Arizona trout, Salmo apache constitutes the only other fish species collected during survey. Origin of this population is questionable in that it has previously been reported as introduced by the Arizona Game and Fish Department (pers. comm. Joe Stone, Arizona Game and Fish Department 1975). However, this report is unsubstantiated by stocking records of the Department, further discussion with a former employee knowledgeable in both native and introduced populations of this species within the region infers no introduction having occurred in Home Creek (pers. comm. Rex Hansen to Jim Novy, Arizona Game and Fish Department 1977). Consequently, Home Creek may represent a native population of Arizona trout. The species is apparently confined to reach SK 3.03-SK4.86 (sm 1.88-sm 3.02) as no fish were recorded either in the uppermost headwater or confluence perennial reaches of Home Creek. Size range of the five specimens collected indicates little or no reproductive success in recent years as small specimens were absent from the collection. Consequently, results of this survey would indicate only marginal success of the population under existing conditions found in Home Creek.

Table 2 - Home Creek Fish Collections, November 18, 1976. Size Range (SLmm) in Parentheses Unless Otherwide Noted.

Species	Station				
	I	II	III	IV	V
Speckled dace, *Rhinichthys osculus*	17 (28-58)	--	--	--	--
Arizona trout, *Salmo apache*	--	3* (106-121)	2* (97-111)	--	--

* Denotes specimens returned live to station and total length (TLmm).

Management objectives for Home Creek should be directed toward maintenance and if feasible enhancement of the native trout fishery. Additional surveys should be conducted at other times of year to substantiate observations of this study or to determine if improved habitat conditions exist. Surveys should comprise both late spring and summer inventories to attempt documentation of reproductive activity and recruitment to the population. Further, the improvement structures should be observed to determine possible effectiveness of the structures at flows above that observed during this investigation. In addition, localities may be selected for installation of improvement structures that would enhance the population throughout the year in the perennial mid-reach occupied by Arizona trout.



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HOME — HAYGROUND CREEKS

DATE 3-1978

FIGURE II

Hayground (Hay) Creek

Haygound Creek is a 7.24 kilometer (4.50 mile) southeasterly-flowing tributary of West Fork of Black River. Confluence (SK 0.00) is located is SE¼SE¼SE¼, Section 19, T5NR28E. Drainage area of this system is 12.0^2 kilometers (4.6^2 miles), ranging in elevation from 2408 meters (7900 ft.) at confluence to a maximum 2804 meters (9200 ft.) near the Fort Apache Indian Reservation boundary. Mean gradient of the system is 54.7 meters/kilometer (288.8 ft./mile) over the stream course.

Hayground Creek was surveyed on November 17, 1976, five sampling stations were established within the system, Table 3. The stream had perennial flow from its confluence with West Fork of Black River to SK 6.79 (sm 4.22), Figure II, the remaining headwater reach, .45 kilometers, was snow-bound. Surface discharge calculated for Station I was 14.1 L/sec. (223.5 gpm), this flow was observed throughout the lower reach of the system to a point ca. .2 kilometers above Station III. Station V discharge was calculated to be 9.2 L/sec. (146.3 gpm). Higher elevations of the drainage area were snow packed at time of survey, consequently these figures should not be inferred as representing mean values. Thermally Hayground Creek is conducive for a salmonid fishery, with temperatures ranging from 11.5°C (52.7°F at Station I to 3°C (37.4°F) at Station V. Chemical parameters recorded for Station V were: Oxygen 10ppm and pH 7.5.

Table 3 - Hayground Creek Sampling Station Locations, November 17, 1976

Station I-----	SW¼NE¼SE¼,	Sec. 19, T5NR28E;	SK 0.35 (sm 0.22)
Station II----	NW¼NW¼NE¼,	Sec. 19, T5NR28E;	SK 1.46 (sm 0.91)
Station III---	NW¼NW¼NW¼,	Sec. 18, T5NR28E;	SK 3.41 (sm 2.12)
Station IV----	NW¼SW¼SE¼,	Sec. 12, T5NR28E;	SK 4.43 (sm 2.75)
Station V-----	SE¼NE¼SE¼,	Sec. 11, T5NR27E;	SK 5.63 (sm 3.50)

No obvious barrier exists in Hayground Creek, however, stream reach SK 4.22-SK 4.63(sm 2.62-2.88) contains numerous .3-1.0 meter(1-3ft.) vertical falls. No fish were collected either in this reach at Station IV, or above in Station V, thus this area may function as a barrier to upstream migration. Gradient of this reach is approximately twice that of the stream course both above and below, ca. 92 meters/kilometer (480ft./mile). A feasible site for construction of a vertical barrier is lacking in the system.

However, due to the abundance of habitat available, the system may warrant consideration for an alternate type of barrier. Below Station II log dam improvement structures are in functioning condition creating pools having maximum depths of ca. 0.5 meter. The stream reach from confluence to midway between Stations III and IV contains abundant pool habitat supporting high density fish populations.

Benthic faunal diversity was low at time of survey with five taxa represented in the collection, Table 4. Sampling was conducted however at the uppermost, Station V, location when extremely harsh conditions were prevalent ice and snow cover was present within and on the system. Consequently, condition was not conducive to either sampling or benthic production thus this collection should not be considered indicative of the system and additional collections should be undertaken.

Table 4 - Taxonomic List of Invertebrates Collected from Hayground Creek, Station V, November 17, 1976.

Taxon	Taxon
Trichoptera Hydropsychidae	Gastropoda Physidae
Diptera Tendipedidae(=Chironomidae)	Acari Oribatei
Coleoptera Dryopidae	

Three fish species were collected in Hayground Creek, Table 5. Brown trout, Salmo trutta dominate the fauna from confluence (SK 0.00) to midway between Stations II and III. No apparent reason exists for this restricted distribution and an upstream extension of their range should be expected. Specimens of hybrid Arizona trout, Salmo apache x S.gairdneri were collected at Station III. Preserved voucher specimens were of three distinct size groups indicating reproductive success of the population, additional individuals of similar size were collected and returned live to the station. Presence of this population indicates former occurrence of pure Arizona trout, Salmo apache in Hayground Creek. Stocking records of the Arizona Game and Fish Department reveal only one former planting of Hayground Creek, on October 10, 1939, 2550 rainbow trout, S. gairdneri four inches in length were planted in the system (Anonomus, 1939). However, this stocking alone did not result in the loss of the pure Arizona trout population as indicated by the following early collection. West Fork of Black River has been planted near annually since at least 1933.

With the absence of a barrier on Hayground Creek some migration of these fish were inevitable, the resultant hybridization unquestionably occurred from this source at an early data. The only known fish collection prior to this study of Hayground Creek, occurred June 21, 1937, by personnel of the University of Michigan Museum of Zoology. Records of that collection indicate both rainbow trout, S. gairdneri (UMMZ 121652, 5 spec. 72-120mm) and speckled dace, R. osculus (UMMZ 121653, 46 spec. 32-81mm) occurred in the system at that time. The remaining species collected, speckled dace, R. osculus was not obtained in either Station I or II samplings, they were however observed in the reach in reduced numbers from the collection at Station III. This observation may indicate the species is heavily preyed upon by brown trout in the lower stream reach. The high density population observed at Station III suggests that stable co-existance is maintained with the Arizona trout hybrid population. This may be indicative of the hybrid trout's utilization of benthic fauna more heavily in its feeding behavior. Numbers of specimens recorded in Table 5 are not representative of the high population densities observed for all species at time of survey.

Table 5 - Hayground Creek Fish Collections, November 17, 1976. Size Range (SLmm) in Parentheses Unless Otherwise Noted.

Species	Station				
	I	II	III	IV	V
Speckled dace, Rhinichthys osculus	--	--	14* (41-69)	--	--
Brown trout, Salmo trutta	2 (95-198)	1 (149)	--	--	--
Hybrid trout, S. apache x S. gairdneri	--	--	3 (70-174) ASU 7151	--	--

* Denotes specimens returned live to station and total length (TLmm).

Hayground Creek may present opportunity for development of an additional Arizona trout fishery providing an adequate barrier can be developed above confluence of the system.

Investigative efforts should be expended to assess alternatives to vertical drop barrier construction and if methodologies are present or can be developed installation of a structure would provide approximately 4.0 kilometers (2.5 miles) of habitat suitable for Arizona trout. Lacking alternate barrier methodology management dictates continued utilization of the system as a natural reproducing brown, native-hybrid trout fishery. This management directive could employ installation of additional improvement structures to further enhance the existing fish population of the system.

Mamie Creek

Mamie Creek is a 6.94 kilometer (4.31 mile) northeasterly flowing tributary of Coyote Creek. Confluence (SK 0.00) is located in NE¼SE¼NW¼, Section 22, T7NR31E. Drainage area of the system is 10.7^2 kilometers (4.1^2 miles), with elevation ranging from 2484 meters (8150 ft.) at confluence to a maximum 3326 meters (10,912 ft.) on top of Escudilla Mountain. Mean gradient of the system is 102.3 meters/kilometer(540.6 ft/mile) over the stream course. This figure however does not depict actual condition of the system above Station V (SK 3.83) as gradient of this reach to stream terminus atop Escudilla is 162.8 meters/kilometer 860.0 ft./mile).

Mamie Creek was surveyed on September 4,1976 with five stations being established at that time, Table 6. Perennial flow was present in the system from confluence with Coyote Creek to SK 4.62 (sm 2.87) Figure III, flow in the remaining headwater reach was attributed to locally occurring precipitation and was not considered perennial. Discharge computed for Station II was 4.6 L/sec.(73.2 gpm), this figure represents data collected during a period of daily occurring precipitation, consequently the figure may be above normally expected flow. The system exhibited thermal conditions marginally high yet conducive to salmonid fisheries with temperatures ranging from a high of 20°C (68°F) at Station I to 16°C (61°F) at Station III. Chemical parameters recorded at Station I were; oxygen, 7.0 ppm and pH of 9.0.

Table 6. Mamie Creek Sampling Stations Locations, September 4, 1976

Station I-----NW¼NE¼SW¼,	Sec. 22, T7NR31E;	SK 0.40 (sm 0.25)
Station II----SE¼NW¼SW¼,	Sec. 22, T7NR31E;	SK 0.77 (sm 0.48)
Station III---NW¼SW¼NE¼,	Sec. 28, T7NR31E;	SK 2.12 (sm 1.31)
Station IV----NE¼SE¼SW¼,	Sec. 28, T7NR31E;	SK 2.91 (sm 1.81)
Station V-----SE¼SE¼NW¼,	Sec. 33, T7NR31E;	SK 3.83 (sm 2.38)

No apparent barrier exists in the system yet collections indicate an absence of fish above Station III, SK 2.12 (sm 1.31). Several vertical falls of .3-1.0 meter (1-3 ft.) are present in the stream reach between Stations III and IV and may preclude upstream movement of the small size class of fishes collected in this system (max. 168 mm SL). Pool indices are low in Mamie Creek, as a result fish densities are below the potential carrying capacity of this system. Improvement structures installed throughout the reach between Station II and V will significantly expand the population of this fishery. The stream reach from confluence to Station II is of low priority to the fishery as stream course herein traverses open meadow and is deeply incised within the alluvium. Additionally, overstory vegetation is virtually non-existant and cover is absent; consequently, improvement in this reach may be impractical.

Mamie Creek supports a single fish species population, Arizona trout, Salmo apache. This population is a result of introductions made on August 21, 1965, September 7, 1967, and October 14, 1968, on these dates 50 (3 inch) 100 (4-11 inch) and 200 (2.5-4 inch) fish respectively were planted above the Stone Creek road crossing of Mamie Creek (Anon. 1965, 1967, 1968).

Collections made during this study, Table 7, indicate that the population is confined to the stream reach between Stations II and III as no specimens were either collected or observed elsewhere. Size frequency distribution indicates the population to be marginally viable with at least three year classes represented in the voucher collections.

Spawning habitat is abundant within Mamie Creek yet only a marginal population exists. The absence of sufficient pool habitat is suspected to be precluding recruitment to the population thus depressing potential level of this species within Mamie Creek.

Table 7 - Mamie Creek Fish Collections, September 4, 1976, Size Range (SLmm) in parentheses.

Species	Station				
	I	II	III	IV	V
Arizona trout *Salmo apache*	--	8 (51-168) ASU 7032	1 (122) ASU 7033	--	--

Benthic fauna exhibits a high index of diversity in Mamie Creek with seventeen families representing eight orders present in the collection, Table 8. Sampling was conducted at Station II in the lower reach, elevation ca. 2512 meters (8240 ft.) Collections were made in run, riffle and pool habitats over cobble, gravel and sand substrate consequently the collections are well representative of the invertebrate faunal base and depict adequate food base for the fishery.

Table 8 - Taxonomic List of Invertebrates Collected from Mamie Creek, Station II, September 4, 1976.

Taxon	Taxon
Ephemeroptera	Diptera
Baetidae	Tendipedidae (=Chironomidae)
Heptageniidae	Tabanidae
Tricorythidae	Heleidae (=Ceratopogonidae)
Trichoptera	Tipulidae
Hydropsychidae	Dixidae
Psychomyiidae	Coleoptera
Glossosomatidae	Hydrophilidae
Plecoptera	Elmidae
Chloroperlidae	Hemiptera
	Naucoridae
	Gastropoda
	Physidae
	Pelecypoda
	Sphaeriidae

Management objectives for Mamie Creek should be directed toward maintenance and enhancement of the Arizona trout fishery. Volume indices are low for the system as pool habitat is deficient is proportion to run and riffle type. Consequently, efforts should be expended to develop additional pool habitat in the system above Station II. Improvement structures installed throughout the reach will provide cover and habitat for expansion of the existing population. The riparian community associated with Mamie Creek is adequate to support beaver activity consequently transplant of this species if successful would provide an alternate to expensive construction cost of stream improvement. Upon improvement, efforts should initially be employed to assist expansion of the population by transplanting fishes from the lower reach to upper section near Station V to establish the species in the apparently barren upper reach.

Davis Creek

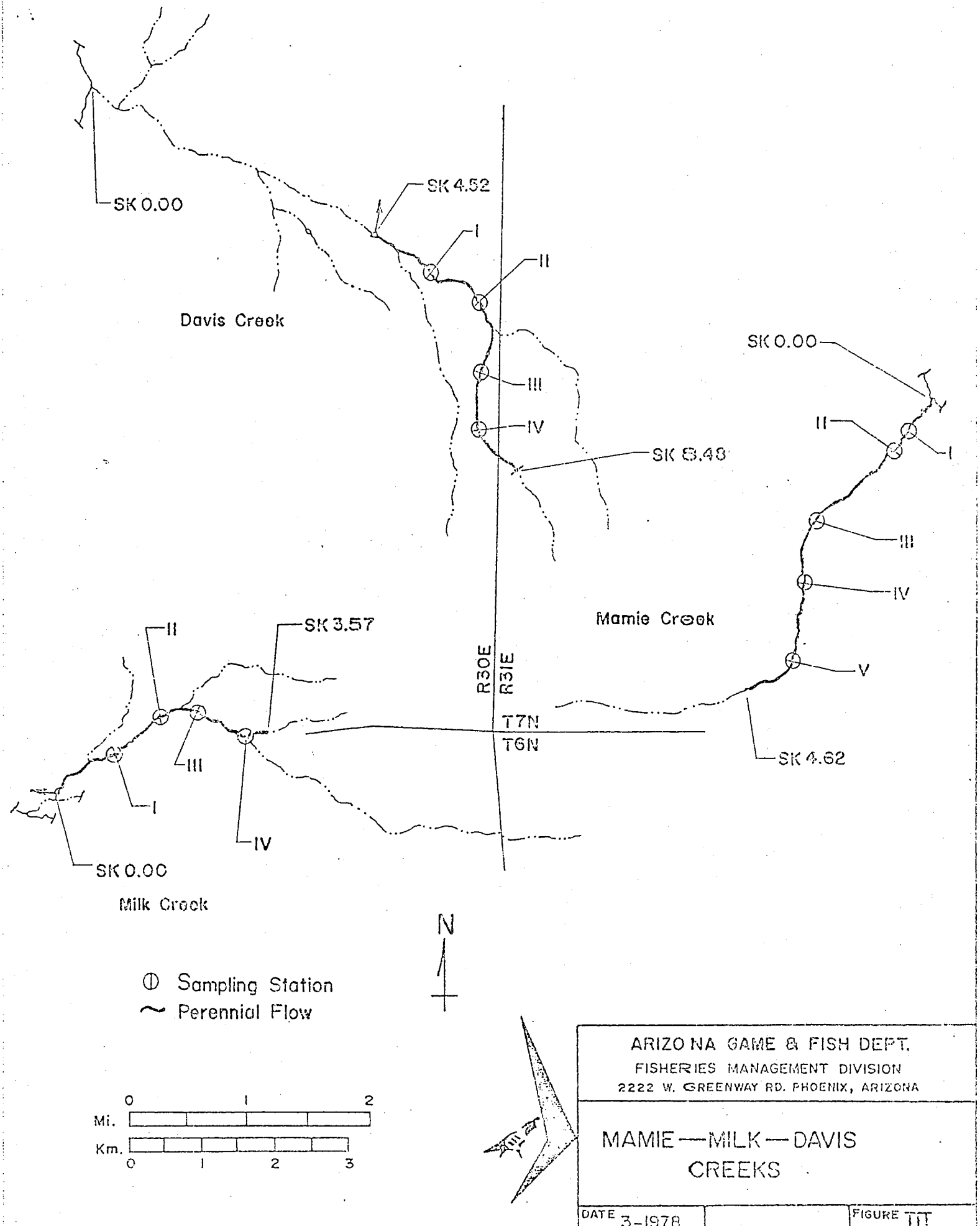
Davis Creek is a 9.88 kilometer (6.14 mile) northwesterly-flowing tributary of Nutrioso Creek. Historical confluence is located in NW¼SW¼SE¼, Section 4, T7NR30E. The Davis Creek drainage area is 18.5^2 kilometers (7.1^2 miles), ranging in elevation from 2,268 meters (7440 ft). at confluence to maximum 3292 meters (10,801 ft.) atop Escudilla Mountain. Mean gradient of the Davis Creek system is 6.17 meters/kilometer (325.7 ft./ mile). However, as with other streams flowing from Escudilla the headwater reach above ca. SK8.0 has a gradient significantly steeper, 217.8 meters/ kilometer (1148.8 ft./ mile) than that of the mean gradient.

Davis Creek was surveyed on September 5, 1976, at that time four stations were established within the system, Table 9. Perennial flow was confined to the intermediate reach of stream course, from the Reagan Reservoir diversion structure, SK 4.52 (sm 2.81) to SK 8.48 (sm 5.27), Figure III. Flow in the upper reach, above SK8.48 was considered to be ephemeral, occurring only in response to local precipitation. No flow occurred in the lower stream course, below diversion. Both at present and in historical time this reach is considered to be intermittent in that no fish were collected in the upper perennial water. Discharge calculated for Station III was 1.8 L/Sec. (29.2 gpm), during survey daily precipitation was occurring, thus this figure may not represent normal flow. Temperature recorded at Station III was 14°C (57°F) thus adequate for a salmonid fishery. Chemical parameters recorded for the same station were; oxygen, 9.0 and pH of 9.0.

Table 9 - Davis Creek Sampling Station Locations, September 5, 1976.

Station I------	NW¼SE¼NW¼, Sec. 13, T7NR30E;	SK 5.31 (sm 3.30)
Station II-----	NE¼NW¼SE¼, Sec. 13, T7NR30E;	SK 6.12 (sm 3.80)
Station III----	NW¼NE¼NE¼, Sec. 24, T7NR30E;	SK 7.11 (sm 4.42)
Station IV-----	NW¼NE¼SE¼, Sec. 24, T7NR30E;	SK 7.82 (sm 4.86)

No vertical barrier exists in the Davis Creek system, however, the Reagan Reservoir diversion structure segregates the lower ephemeral reach from the perennial headwater. Adequate sites for construction of an economically feasible barrier are also lacking in the system.



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MAMIE — MILK — DAVIS CREEKS

DATE 3-1978

FIGURE III

Habitat throughout the lower perennial reach from diversion to Station III, SK 7.11 (sm 4.42) is low value for fishery consideration. The stream course within this reach is a deeply incised channel meandering through alluvial fill with habitat dominated by runs over sand-silt substrate. Cover within this zone is essentially non-existant as virtually no reparian vegetation exists adjacent the stream course due to continual sloughing of the alluvium.

The 1.37 kilometer (0.85 mile) headwater reach above Station III provides habitat of potential value for establishment of a minor fishery. This area is predominately run and riffle type with few pools present. Consequently, to achieve optiumum yield improvement structures should be installed within this reach to develop pool-volume indices conducive to establishment of a fishery. Substrate is predominately gravel-cobble-rubble within this reach consequently the zone should provide spawning habitat to support a minor self-sustaining fishery.

Davis Creek supported no fish fauna at time of survey and records indicate no previous collections have been made within this system. This observation infers a total isolation of the drainage from Nutrioso Creek either due to the Reagan Reservoir diversion structure, the intermittent reach above confluence or combination of both factors. If improved this system could support a minor native salmonid fishery, however, the stream is sufficiently accessible that subsequent undersirable introduction could readily be undertaken thus jeopardizing an established fishery.

Benthic faunal collection in Davis Creek indicated relatively low diversity with only seven taxa represented in the sample, Table 10, however, this collection was made at Station III an area intermediate in quality between the headwater and meadow alluvial reaches. Habitat in this area is predominately run type over gravel-sand substrate thus not conducive to benthic development and is not considered representative of the food base potentially inherent in the headwater reach of the system.

Table 10 - Taxonomic List of Invertebrates Collected from Davis Creek, Station III, September 5, 1976.

Taxon	Taxon
Trichoptera	Coleoptera
Leptoceridae	Hydrophilidae
Diptera	Oligochaeta
Tendipedidae(=Chironomidae)	Pelecypoda
Heleidae (=Ceratopogonidae)	Sphaeriidae
Tipulidae	

Davis Creek warrants only minor consideration in developing priorities for native salmonid management. However, the 1.37 kilometer (0.85 mile) headwater reach is suitable for establishment of a fishery if developed. Improvement structures installed within this reach would provide pool habitat sufficient to support a minor population of Arizona trout, S. apache. Prior to installation of structures additional benthic collections should be made in the headwater area to determine composition of the invertebrate community as collections made in this study depict a low diversity notconducive to supporting establishment of a fishery.

Milk Creek

Milk Creek is a 8.35 kilometer (5.19 mile) westerly-flowing tributary of the Milk-Hulsey Creek drainage. Confluence (SK 0.00) of the two streams is located in NE¼NW¼SW¼ Section 4, T6NR30E, .44 kilometers upstream from their joint confluence with Nutrioso Creek. Drainage area of the Milk Creek segment of this system is 14.1 km^2 kilometers (5.4 mi^2 miles), ranging in elevation from 2337 meters (7830 ft.) at confluence to a maximum 3326 meters (10,912 ft.) atop Escudilla. Mean gradient is 93.8 meters/kilometer (495.2 ft./mile) over the stream course.

Milk Creek was surveyed on September 6, 1976, four stations were established with the system, Table II. From confluence to SK 0.06 (sm 0.04) the stream course was dry, a diversion structure located at this point impounds and diverts water of Milk Creek for irrigation above the community of Nutrioso. Perennial flow occurs from the diversion to SK 3.57 (sm 2.22) on"North Fork", in SW¼SW¼, Section 35, T7NR30E, Figure III. Above Station IV on the main branch, Milk Creek flow was ephemeral, that present being attributed to local precipatation. Discharge calculated at Station I was 5.8 L/sec. (92.0 gpm), at time of survey. As with other streams surveyed in the Escudilla Area, local precipatation may have biased this figure above normal mean flow. Milk Creek was thermally adequate for salmonid species at time of survey with temperature recorded at Station I being 15°C (59°F). Chemical parameters recorded at the same station were: Oxygen, 7.0 ppm; and pH of 9.0.

Table 11 - Milk Creek Sampling Station Locations, September 6, 1976.

Station I------	SE¼NW¼NE¼,	Sec. 4,	T6NR30E; SK 1.00 (sm 0.62)
Station II-----	SE¼SW¼SW¼,	Sec. 34,	T7NR30E; SK 1.80 (sm 1.12)
Station III----	NW¼SW¼SE¼,	Sec. 34,	T7NR30E, SK 2.46 (sm 1.53)
Station IV-----	SE¼SE¼SE¼,	Sec. 34,	T7NR30E; SK 3.22 (sm 2.00)

A vertical barrier is lacking in Milk Creek, however, the diversion structure apparently prevents upstream migration of fishes from Nutrioso Creek during periods of flow in the lower reach. This structure may , however, be subject to failure during extreme high flow and should not be considered assurance to isolation of the Milk Creek system. A barrier site was located during survey at Station III, SK 2.46 (sm 1.53), at this location the stream traverses a bedrock slide and falls approximately two meters. Construction of a barrier at this location would create approximately one kilometer (0.62 miles) of habitat distinctly isolated from the lower reach and Nutrioso Creek.

Habitat within Milk Creek is dominated by run and riffle type, however, pool habitat is present and volume indices are superior to that observed in Davis Creek. The stream reach above Station II, SK 1.80 (sm 1.12) to terminus exhibited adequate overstory vegetation to provide cover for establishment of a fishery. Below Station II habitat is noticeably inferior to the upper reach as the stream course traverses open meadow and is incised within alluvial fill. Habitat of this reach is predominately run type, the substrate, however, remained gravel-rubble with only minor indication of excessive fines. Overstory canopy is lacking in this reach, as a result the lowermost section of Milk Creek, below Station II, is of minimal value to development of a fishery.

No fish were either collected or observed in Milk Creek during survey, this finding infers isolation of the system from Nutrioso Creek. If improved Milk Creek could sustain a minor self-supporting native trout fishery. Access to the system is limited to non-vehicular travel, consequently the probability of undesirable introduction is low thus favoring this stream for introduction of Arizona trout, S.apache.

Benthic faunal diversity of Milk Creek is low based upon samples taken during this investigation with five taxa represented in the collection, Table 12. This sampling, however, was made at Station I in the lowermost reach and may not be indicative of the headwater habitat. Sampling was made in run habitat over gravel substrate, consequently, not optimum condition for benthic development.

Table 12 - Taxonomic List of Invertebrates Collected From Milk Creek Station I, September 6, 1976.

Taxon	Taxon
Ephemeroptera	Trichoptera
Baetidae	Hydropsychidae
Plecoptera	Coleoptera
Chloroperlidae	Elmidae
Diptera	
Tendipedidae (=Chironomidae)	

Management objectives for Milk Creek should be directed toward development for and establishment of an Arizona trout, S. apache fishery. Barrier construction at the Station III site will segregate the one kilometer headwater reach from the remainder of the system thus providing additional isolation for a reservoir population to exist in the headwater. Improvement structures installed throughout the stream above Station II will enhance volume indices beyond existing condition thus providing habitat throughout the 1.77 kilometer (1.10 mile) upper reach of Milk Creek. Prior to initiating development projects additional benthic collections should be conducted in the system above Station II to determine if invertebrate diversity is above that observed during this study as that reported herein is marginal to support establishment of a fishery.

Blue River

The Blue River is an approximately 80 kilometer (50 mile) south flowing perennial trubutary of the San Francisco River with confluence located 26 kilometers (16 miles) upstream from the community of Clifton. The Blue River originates at the confluence of Campbell Blue and Dry Blue creeks, 0.52 kilometers inside New Mexico. Drainage area elevations vary from 1189 meters (3900 feet) at confluence to over 2866 meters (9400) feet) near Hannagan Meadow. Mean gradient of the system is approximately 9.5 meters/kilometer (50 ft./mile) over the river course.

Preliminary investigation of the Blue River was initiated during this study with five sampling stations established on June 22, and July 27, and 29, 1976 Table 13. Perennial flow was present throughout the system at time of survey. Discharge calculated for Station IV was 0.35^3 meters/second (12.4 cfs). Temperatures recorded for Stations I and IV were 19.5^0C (67.1^0F) and 22^0C (71.6^0F) respectively inferring only marginal suitability for salmonids. Chemical parameters measured throughout were constant in both oxygen and pH at 8.0-9.0 ppm and 9.5 respectively.

Table 13 - Blue River Sampling Station Locations, June 22, and July 27, 29, 1976

Station I----	SE¼NW¼NE¼,	Sec. 23, T2NR30E;	SK 44.74 (SM 27.80), June 22, 1976
Station II---	SE¼SE¼SE¼,	Sec. 11, T2NR30E;	SK 47.02 (SM 29.22), June 22, 1976
Station III--	SE¼NW¼SW¼,	Sec. 1, T2NR30E;	SK 49.58 (SM 30.81), July 27, 1976
Station IV---	SE¼SW¼SW¼,	Sec. 18, T4NR32E;	SK 75.07 (SM 46.65), July 27, 1976
Station V----	NE¼SE¼SE¼,	Sec. 5, T4NR32E;	SK 80.92 (SM 50.28), July 29, 1976

Habitat of the Blue River is markedly varied throughout the reach observed during this investigation. Riffle and run types dominate the system, however, pool habitat is present in some localities.

The stream exhibits evidence of severe scouring resulting from former floods, however, marginal succession is apparent in some localities and may eventually return portions of the system to preflood productivity. Marginal beaver activity is hastening restorative processes in the upper reach between stations IV and V, and this effort should be encouraged.

Benthic faunal diversity was relatively high in the Blue River with eight orders and twenty-one families represented in the collection, Table 14. Stream morphology and flow were conducive to effective sampling as both pool and riffle habitats had adequate flows to be sampled along both bank and midstream situations over sand, gravel, and boulder substrates. The only neuropteran collected during this study, represented by the family Corydalidae (dobsonfly) was taken in this sampling.

Table 14 - Taxonomic List of Invertebrates Collected from Blue River, Station II, June 22, 1976.

Taxon	Taxon
Neuroptera (=Megaloptera)	Coleoptera
Corydalidae	Dryopidae
Ephemeroptera	Gyrinidae
Baetidae	Elmidae
Heptageniidae	Hydrophilidae
Trichoptera	Hemiptera
Hydropsychidae	Belostomatidae
Hydroptilidae	Gerridae
Glossosomatidae	Gastropoda
Diptera	Physidae
Tendipedidae (=Chironomidae)	Acari
Simuliidae	Oribatei
Heleidae (=Ceratopogonidae)	
Stratiomyidae	
Tipulidae	
Empididae	
Tabanidae	

Blue River displayed the greatest diversity of fish fauna observed during investigation with six species represented in the collection, Table 15. Previous to this study only three recorded collections are known from this system. On September 2, 1964 a collection made "two miles north of Blue" yielded four species: Gila sucker, C. insignis (ASU 1335); Gila mountain sucker, P. clarki (ASU 1336); longfin dace, A. chrysogaster (ASU 1337) and speckled dace, R. osculus (ASU 1338). The second and third collections were made on December 12, 1967 near Fritz Ranch. The first recorded as "above Frity Ranch" yielded the same species as the 1964 record (ASU 4861, 4860, 4862 and 4863), the second entry indicated as "Station II" recorded:

Gila-mountain sucker, P. clarki (ASU 4820); longfin dace, A. chrysogaster (ASU 4821); speckled dace, R. osculus (ASU 4822) and loach minnow, Tiaroga cobitis (ASU 4823). Stocking of exotic salmonids has provided additional diversity to the Blue River fauna since at least 1933 with brown, rainbow, and "native" cutthroats having been introduced to provide a sport fishery (Anon, 1933).

Collections during this investigation indicate the Blue River fauna is comprised of the same five native species and one exotic. Voucher specimens retained infer viable population exist for all native species collected except the loach minnow, T. cobitis which was represented by only a single specimen, consequently no inference can be made as to structure of its population. Speckled dace, R. osculus in the numerical dominant of the Blue River fauna and was distributed throughout the system. Gila sucker, C. insignis exhibited similar distribution, but was encountered in reduced numbers from the previous species. Longfin dace, A. chrysogaster and Gila mountain sucker, P. clarki displayed similar overall distribution to the above species, but each was absent from collection at a single station. The remaining native species is represented by a single specimen of loach minnow, T. cobitis taken at Station I. This uncommonly encountered species is a characteristic inhabitant of large riffle type habitats and is sporadically distributed in the Gila River drainage of both Arizona and New Mexico. Prior to collections and records, herein, only two populations centers were known to remain for this species in Arizona. Consequently, this collection is of importance to understanding the distribution of this unique native fish. The exotic rainbow trout, S. gairdneri constitutes the remaining species collected during investigation. Blue River receives near annual plantings of this species to provide a recreational fishery, consequently no inference can be made as to origin of specimens collected or population viability of the species with the system.

Table 15 - Blue River Fish Collections, June 22, and July 27, 29, 1976
Size Range (SL mm) in Parentheses.

Species	STATION I	II	III	IV	V
Longfin dace, Agosia chrysogaster	4 (47-66)	--	3 (56-62)	--	21 (40-64)
Speckled dace, Rhinichthys osculus	22 (37-56)	26 (37-66)	3 (41-56)	--	16 (38-72)
Loach minnow, Tiaroga cobitis	1 (45) ASU 6961	--	--	--	--

Table 15 - Blue River Fish Collections, June 22, and July 27, 29, 1976. Size Range (SL mm) in Parentheses. (Continued)

Species	STATION I	II	III	IV	V
Gila Mt. sucker, Pantosteus clarki	7 (51-127)	16 (38-104)	4 (96-147)	--	--
Gila sucker, Catostomus insignis	4 (58-225)	6 (84-131)	3 (70-131)	--	8 (61-121)
Rainbow trout, Salmo gairdneri	1 (166)	2 (117-126)	1 (153)	--	--

Equipment failures during survey precluded establishment of additional stations and collection of fish at Station IV, consequently further data is required to adequately assess the system. Surveys should be undertaken to establish stations intermediate and below area investigated during this study to determine distribution of the fauna, in particular the loach minnow, T. cobitis.

Strayhorse Creek

Strayhorse Creek is a 17.90 kilometer (11.12 mile) easterly flowing tributary of the Blue River, confluence SK 0.00 is located in NE¼SE¼SE¼, Section 26, T2NR30E approximately 39 kilometers (25 miles) upstream of the San Francisco River. Drainage area of the system is 76.04^2 kilometers (29.36^2 miles) ranging in elevation from 1484 meters (4870 feet) at confluence to a maximum 2675 meters (8776 feet) on Rose Peak. Mean gradient of the stream is 43.1 meters/kilometer (227.5 ft./mile) over its course.

Strayhorse Creek and its major tributaries Lengthy and Hogans Corral Canyons were surveyed during two periods of this study; May 22- 26, and June 17,18, 1976; only four stations were established in the 35.3 kilometers (21.9 miles) of drainage inventoried, Table 16. Perennial flow of the sytem was confined to three discrete reaches totaling 1.38 kilometers (0.86 miles) at time of survey, Figure IV, the remainder was considered ephemeral. Discharges calculated for Stations I, II and III were: 5.1 L/second (80.8 gpm), 2.1 L/second (33.6 gpm) and 8.5 L/second (134.6 gpm) respectively at time of survey. Thermal conditions observed at the same stations ranged from 18°C (64.4°F) at Station I to 15°C (59°F) at Station III, pH of 9.0 was constant at all stations, oxygen was also stable throughout at 9.0 ppm except at Station I which was recorded at 5.0 ppm. These observations indicate suitability for salmonid fisheries, however, the minimal flows observed preclude any consideration for introduction or enhancement.

Table 16 - Strayhorse Creek Sampling Station Locations, June 17,18, 1976.

Station I---NW¼SE¼SE¼, Sec. 26, T2NR30E; SK 0.32(sm 0.20) June 18, 1976
Station II--SE¼SE¼NE¼, Sec. 28, T2NR30E(unsur); SK 3.62(sm 2.25) June 18, 1976
Station III-SE¼SE¼NW¼, Sec. 28, T2NR30E(unsur); SK 4.55(sm 2.83) June 17, 1976
Station IV--NW¼NW¼SW¼, Sec. 28, T2NR30E(unsur); SK 5.50(sm 3.42) June 17, 1976

A single barrier was located in Strayhorse Creek during investigation at SK 5.82 (sm 3.62) estimated to be vertical drop of 4.5 meters (15 ft.). However, above this locality the system has only 0.40 kilometers (0.25 miles) of marginal perennial habitat, consequently the barrier is of little or no value. Similarly, habitat value of the lower reach is of minimal importance as the system is dominated by run and riffle type other than the pool complex immediately below the barrier. the associated riparian community provides abundant shading to the system, however, sufficient habitat is lacking to warrant consideration for establishment of a fishery.

Station I invertebrate fuanal collections depict relatively low diversity, for the system, Table 17. However, due to minimum flow occurring at time of survey limitations of the sampling equipment may have contributed to the sparcity of taxa represented in the collection (hynes, 1970). Numerous dessicated trichopteran (caddisfly) pupal cases of the family Glossosomatidae were exposed adjacent the stream course where flow was subterranean, suggesting a previous period of higher productivity than observed during study.

Table 17-Taxonomic Listof Invertebrates Collected from Strayhorse Creek, Station I, June 18, 1976.

Taxon	Taxon
Ephemeroptera	Coleoptera
Baetidae	Dryopidae
Heptageniidae	Dytiscidae
Siphlonuridae	Hemiptera
Trichoptera	Belostomatidae
Hydropsychidae	Corixidae
Hydroptilidae	
Glossosomatidae	
Diptera	
Tendipedidae (=Chironomidae)	
Simuliidae	
Heleidae (=Ceratopogonidae)	
Empididae	

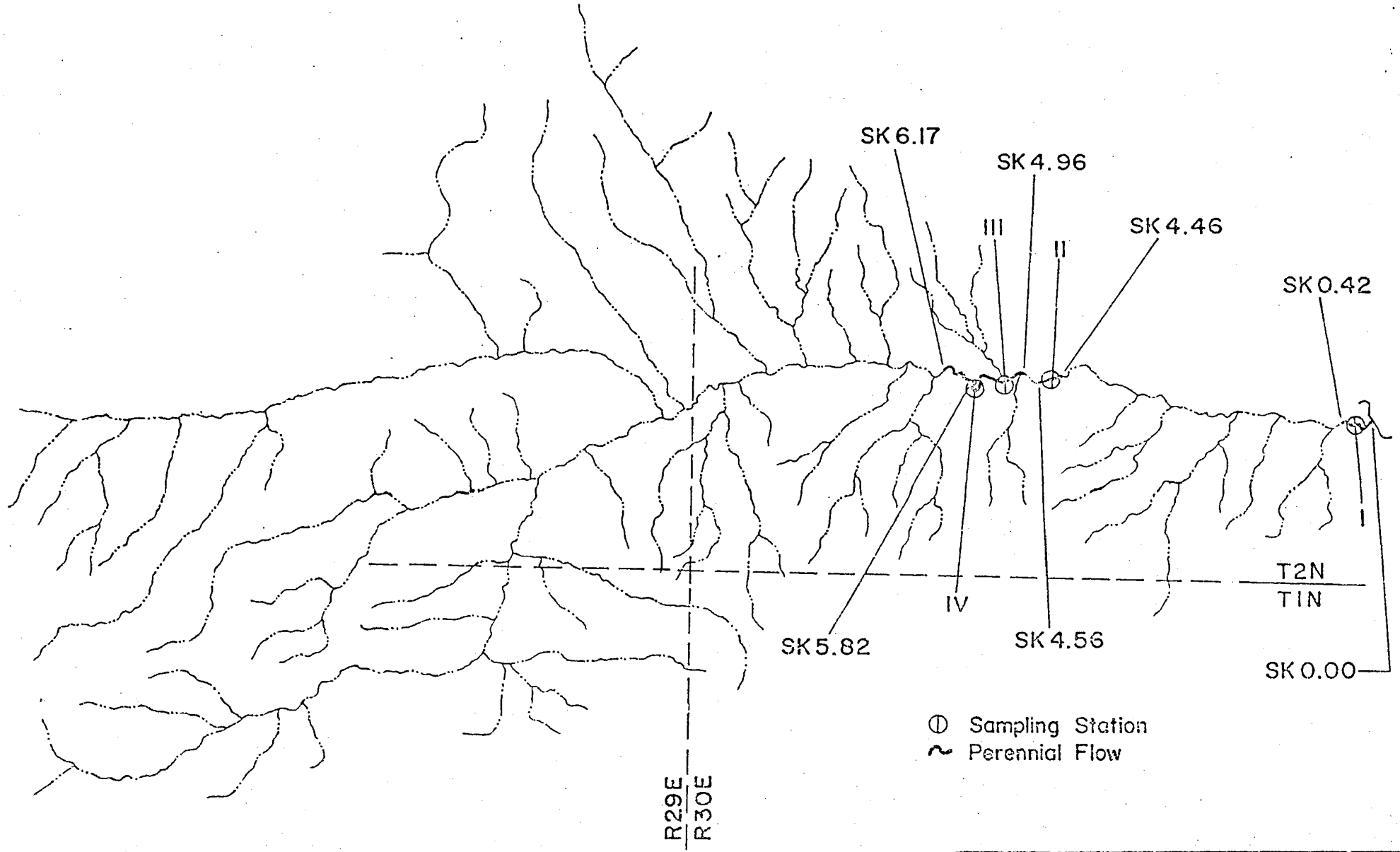
The Strayhorse Creek fishery is comprised of four species, three native and one exotic restricted to the lowermost perennial reaches below barrier, Table 18. Voucher specimens retained during survey, indicate viable populations on only the native species with three distinct size classes represented for each. The longfin dace, A. chrysogaster was numerically dominant in the fuana of Strayhorse Creek and distributed throughout the lower perennial reach. Speckled dace, R. osculus the second-most abundant species in the system exhibited similar distribution except being absent at Station II. The Gila-mountain sucker, P. clarki was restricted to pool and deeper water habitats in Stations III and IV. The fourth species collected, rainbow trout, S.gairdneri undoubtedly represents a migrant extension of Blue River fauna, isolated during a period of higher flow and subsequent receding water. The species is confined in distribution to the plunge pools immediately below the barrier locality. No fish were either collected or observed above the barrier locality.

Table 18 -Strayhorse Creek Fish Collections. Size Range (SL mm) in Parentheses Unless Otherwise Noted.

SPECIES	STATION I	II	III	IV
Longfin dace, Agosia chrysogaster	11 * (47-58)	9 * (49-65)	12 (12-60)	10 (12-61)
Speckled dace, Rhinichthys osculus	6 * (47-54)	--	1 (17)	12 (48-60)
Gila Mt. sucker Pantosteus clarki	--	--	5 (22-109)	3 (97-120)
Rainbow trout Salmo gairdneri	--	--	--	3 (164-178)

*Denotes specimens returned live to station and total length (TLmm).

Strayhorse Creek provides no opportunity for additional fishery establishment or enhancement at conditions observed during this investigation. The system supports only a minor native species fishery complex and should not be considered for salmonid fishery development. Future surveys could be undertaken to monitor trend in the native fishery at infrequent intervals.



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STRAYHORSE CREEK

DATE 3-1978

FIGURE IV

Raspberry Creek

Raspberry Creek is a 14.68 kilometer (8.37 mile) easterly flowing tributary of the Blue River confluence SK 0.00 is located in NW¼NW¼SE¼, Section 23, T2NR30E approximately 44 kilometers (27 miles) above confluence of the Blue and San Francisco rivers. Drainage area of the system is 28.39^2 kilometers (10.96^2 miles) ranging in elevation from 1750 meters (5030 feet) at confluence to a maximum 2851 meters (9346 feet) on Blue Lookout. Mean gradient of the system is 55.2 meters/kilometer (402.6 ft./mile) over the stream course.

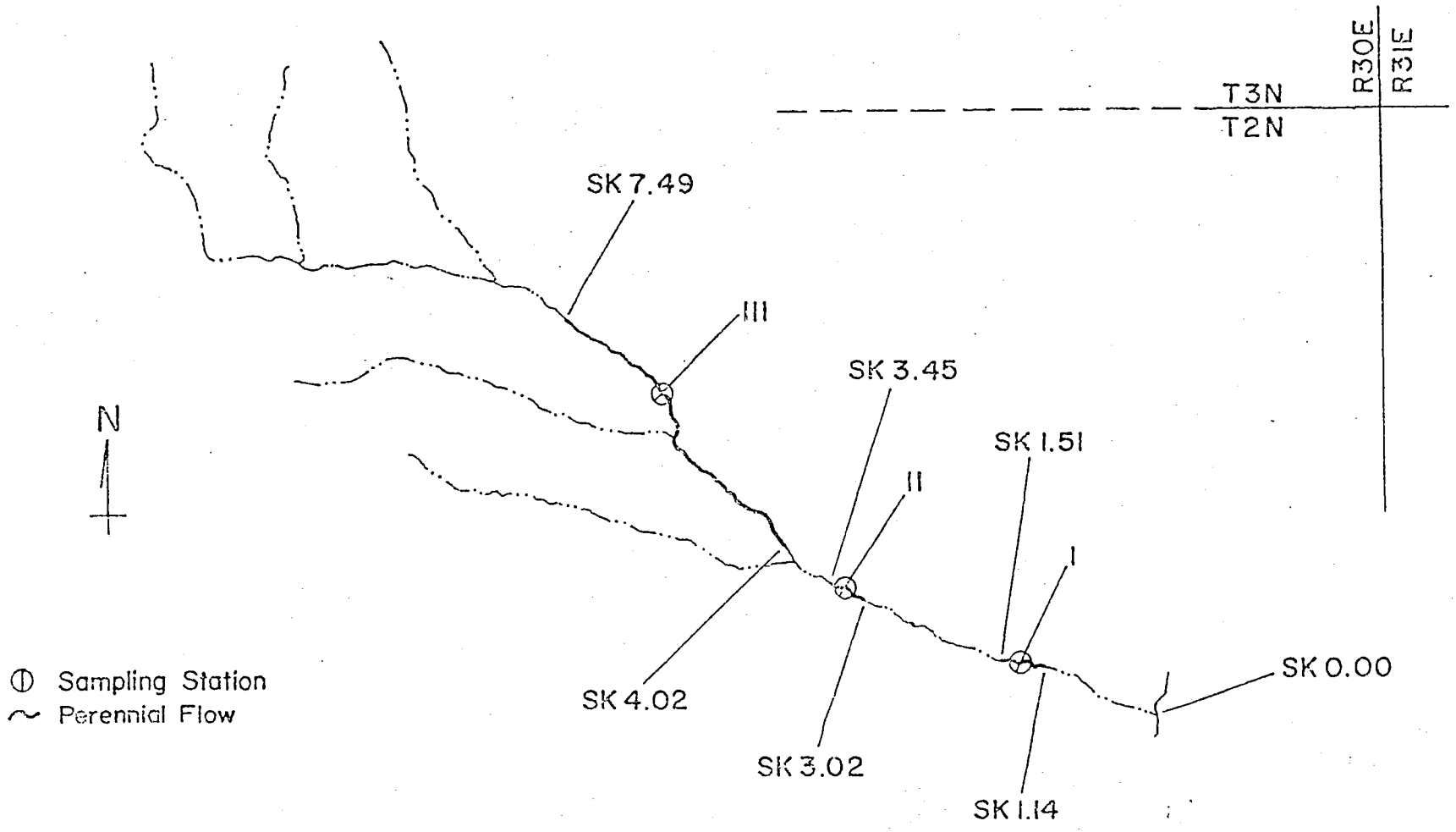
Raspberry Creek was surveyed on three occasions during this investigation, three sampling stations were established, Table 19. Perennial flow of this system was confined to three distinct reaches totaling 4.27 kilometers (2.65 miles) on dates of survey, Figure V, the remaining reaches were ephemeral in character. Discharge data calculated for Station II was 4.8 L/second (76.3 gpm) at time of survey. Temperatures recorded for Stations I, II, and III were 16.5°C (61.7°F), 18.5°C (65.3°F) and 19.5°C (67.1°F) respectively. Chemical parameters recorded at the same localities were: oxygen, 3.0, 5.0 and 9.0 ppm; pH 9.0, 8.5 and 9.0. These observations suggest that only the upper reach near Station III is suitable for salmonid fishery consideration.

Table 19 - Raspberry Creek Sampling Station Locations, May 25, and June 19, 21, 1976.

Station I----	NW¼SE¼NE¼, Sec. 22, T2NR30E(unsur);	SK 1.35 (sm 0.84),	June 21, 1976
Station II---	NW¼SE¼SE¼, Sec. 16, T2NR30R(unsur);	SK 3.32 (sm 2.06),	June 19, 1976
Station III--	SE¼NW¼SE¼, Sec. 8, T2NR30R(unsur);	SK 6.08 (sm 3.78),	May 25, 1976

No barrier exists in Raspberry Creek nor were sites found within the system feasible for barrier construction. The upper 3.47 kilometer (2.16 mile) perennial reach provided moderate pool habitat at time of survey, volume indices were marginally adequate to support a minor salmonid fishery. Riparian vegetation contributed abundant shade and cover throughout the reach. The lower perennial reaches of the system are predominately run and riffle habitat and present no opportunity for fishery development or enhancement at conditions observed.

Raspberry Creek benthic collection was analogous to that of Strayhorse Creek, low flow and absence of suitable sampling localities precluded efficient collection. Consequently, though diversity is moderate these factors may have contributed to omisssion of some commoner taxa from the listing of benthic faunal structure, Table 20.



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RASPBERRY CREEK

DATE 3-1978

FIGURE V

Table 20 - Taxonomic List of Invertebrates Collected From Raspberry Creek, Station I, June 21, 1976.

Taxon	Taxon
Ephemeroptera	Diptera
Baetidae	Tendipedidae (=Chrionomidae)
Heptageniidae	Simuliidae
Tricorythidae	Heleidae (=Ceratopogonidae)
Plecoptera	Stratiomyidae
Chloroperlidae	Rhagionidae
Trichoptera	Tipulidae
Hydropsychidae	Dixidae
Hydroptilidae	Empididae
Glossosomatidae	Odonata
	Agrionidae
	Gomphidae
	Hemiptera
	Corixidae
	Gerridae

The Raspberry Creek fishery is comprised of three native species Table 21. The speckled dace, R. osculus is distributed throughout perennial reaches of the system and is numerically dominant in the fauna. Size structure of this population indicates viability with three size classes represented in the collection. Longfin dace, A. chrysogaster is secondary in the faunal structure of the system based on visual estimations as voucher specimens do not support this contention. The least common occuring species is Gila mountain sucker, P. clarki collected only at Station II, size structure of voucher specimens indicates a single year class possibly inferring a migrant extension of Blue River fauna entrapped by receding flows.

Table 21 - Raspberry Creek Fish Collections, May 25, and June 19, 1976 Size Range (SL mm) in Parentheses.

SPECIES	STATION I	STATION II	STATION III
Longfin dace *Agosia chrysogaster*	--*	1 (41)	--
Speckled dace, *Rhinichthys osculus*	6 (39-54)	21 (42-59)	39 (30-64)
Gila Mt. sucker, *Pantosteus clarki*	--	3 (41-49)	--

*Denotes species observed, but not collected.

Raspberry Creek in the uppermost perennial reach is marginal habitat to provide a minor salmonid fishery at conditions observed. Inaccessibility to an remoteness of the system suggest consideration be given toward attempted establishment of a native salmonid in the 3.47 kilometer reach. Distribution of P. clarki suggests the lower ephemeral reach may function as an effective barrier to upstream migration from Blue River thus precluding exotic salmonid invasion. However, prior to introduction additional survey should be conducted to determine change in P. clarki distribution or exotic species invasion not observed during this investigation.

Campbell Blue Creek

Campbell Blue Creek is a 35.55 kilometer (22.09 mile) easterly flowing tributary of the Blue River, Campbell Blue and Dry Blue creeks form the Blue River with their confluence SK 0.00 located .80 kilometers inside New Mexico. Drainage area of this system is 195.57^2 kilometers (75.51^2 miles, ranging in elevation from 1951 meters (6400 feet) at confluence to a maximum 2761 meters (9058 feet) on Tenney Mountain. Mean gradient of the system is 22.8 meters/kilometer (120.3 feet/mile) over the stream course. However, a zone of higher gradient exists through the 3.2 kilometer (2.0 mile) reach above the confluence of Coleman Creek where the gradient approximates twice that of the system mean.

Campbell Blue Creek was surveyed during three different periods of this study; July 28,29, 1976; June 14,15, 1977 and August 18, 1977, eleven sampling stations were established in the sytem during these periods, Table 22. This system has perennial flow from SK 0.00 to SK 15.69 (sm 9.75), above this point the stream is interrupted perennial in character, having five discrete reaches with permanent water, Figures VI & VII . Supportive flow is contributed to Campbell Blue Creek by three perennial tributaries; Coleman, Castle-Buckalou, and Turkey creeks. Data on these systems are presented elsewhere in this report. Discharge data calculated for Campbell Blue Stations I,III and V were 0.13^3 meters/second (4.61 cfs), 0.16^3 meters/second (5.75 cfs) and 0.10^3 meters/second (3.60 cfs) respectively, during the sampling periods of this study.

Thermally Campbell Blue Creek appears only marginal for a salmonid fishery with temperature recordings at Stations I, II, III, and IX being 29^0 C (84.2^0 F), 27^0 C (80.6^0 F), 25^0 C (77^0 F) and 26.5^0 C (79.7^0 F) respectively at mid-afternoon samplings taken during this investigation. Only station V exhibited temperature condition considered conducive to salmonid species at 16.5^0 C (61.7^0 F).

These data, however, are regarded maxima for the system as all recordings were taken mid-afternoon following extremes of thermal loading. Additionally, stations exhibiting these high temperatures all lacked riparian overstory thus resulting in conditions for optimum radiant input. Diurnal variation in temperature is known to approximate 6^{0} C (10.8^{0} F) in stream habitats, consequently observations made during this study should not be inferred as typical thermal values rather upper limits with reduced temperatures occurring throughout other periods that are conducive to salmonids. Chemical parameter ranges recorded at the same stations were: oxygen, 7.0-9.0 ppm, pH, 8.7 - 9.5

Table 22 - Campbell Blue Creek Sampling Station Locations, July 28,29, 1976, June 14,15 and August 18, 1977.

Sta. I-----NE¼NE¼NE¼, Sec. 5,T4NR32E; SK 1.21 (sm 0.75) 28 July 1976
Sta. II----SW¼SE¼NE¼, Sec. 31,T4½NR32E; SK 3.93 (sm 2.44) 28 July 1976
Sta. III---NE¼SW¼NE¼, Sec. 36,T4½NR31E(unsur); SK 6.13 (sm 3.81) 28 July 1976
Sta. IV----SW¼SE¼NW¼, Sec. 35,T4½NR31E(unsur); SK 8.85 (sm 5.50) 29 July 1976
Sta. V-----SW¼SE¼NE¼, Sec. 33,T4½NR31E(unsur); SK 11.47 (sm 7.13) 18 August 1977
Sta. VI----SW¼NW¼NE¼, Sec. 32,T4½NR31E(unsur); SK 13.98 (sm 8.69) 15 June 1977
Sta. VII---SE¼SE¼NW¼, Sec. 31,T4½NR31E(unsur); SK 16.40 (sm 10.19) 15 June 1977
Sta. VIII--SW¼NE¼SE¼, Sec. 26,T4½NR30E(unsur); SK 20.42 (sm 12.69) 15 June 1977
Sta. IX----NE¼SW¼SE¼, Sec. 22,T4½NR30E(unsur); SK 23.83 (sm 14.81) 14 June 1977
Sta. X-----SE¼SE¼NE¼, Sec. 35, T5NR29E SK 28.07 (sm 17.44) 14 June 1977
Sta. XI----SE¼NE¼SE¼, Sec. 27, T5NR29E; SK 30.48 (sm 18.94) 14 June 1977

No barrier exists in Campbell Blue Creek nor were sites found within the lower perennial reach feasible for construction of a barrier. The upper interrupted reach lacks sufficient habitat to warrant barrier construction consideration. Consequently, the system is not conducive for native salmonid introduction. The system does, however, provide a moderately high brown trout, Salmo trutta fishery and should be considered for enhancement to further develop this resource. Historically, the system was noted for abundant beaver activity contributing markedly to the development of this fishery through creation of abundant pool habitat. At present, beaver activity is exhibiting marginal recovery after population decline resulting from severe flooding in former years, the most detrimental occurring in 1959. Currently, the activity is confined to the stream reach between SK 8.45 (sm 5.25) and SK 15.00 (sm 9.32) with the dominance occurring above confluence of Castle Creek SK 11.46 (sm 7.12).

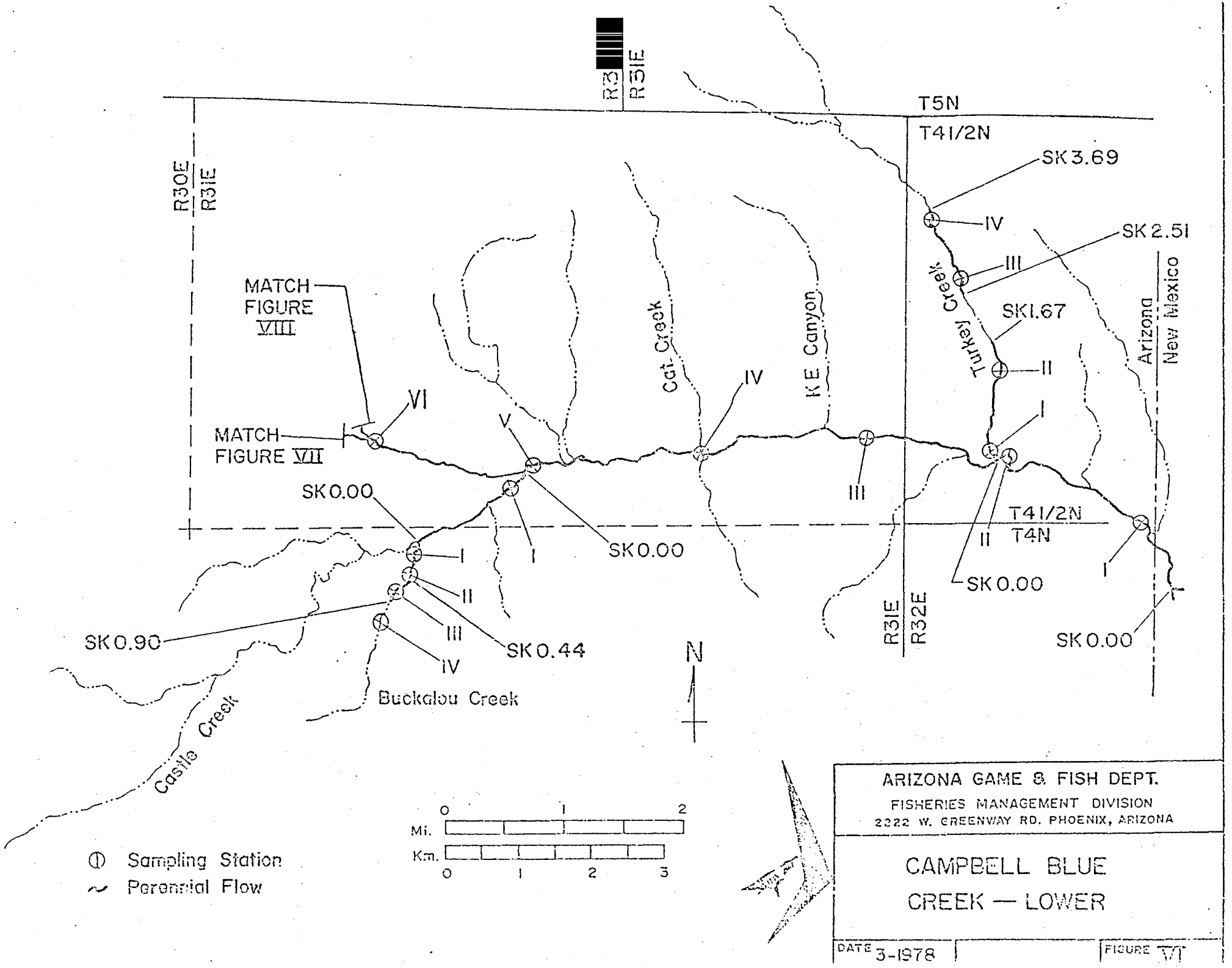
Campbell Blue Creek exhibits three distinct habitat quality types within its 35 kilometer stream course. From confluence to approximately one kilometer below Station V the system displays noticeable evidence of extreme scouring resulting from former floods. Habitat is predominately run and riffle type with pools only minimally existant. Riparian vegetation immediately adjacent the stream course is markedly lacking throughout this reach with only marginal regrowth evident.

Similarly, the overstory canopy is significantly reduced throughout the reach, contributing little shading to the system. Livestock grazing is evident, presumably retarding regeneration capabilities of the vegetative complex adjacent the stream course. The continuum perennial reach above Station V to SK 15.69 (sm 9.75) presents habitat noticeably different. Riparian vegetation markedly increases throughout this reach significantly contributing shade and cover to the system frequently approximating 100 percent. Pool habitat is abundant, consequently volume indices are conducive to a markedly improved fishery. Above SK 15.69 the system is segmented into five discrete perennial reaches. The upper four units of this complex display similar habitat type, meandering pool-runs incised within meadow aluvial fill. The lowermost section of this reach, Station VII, is a single pool with approximately 15 meters of associated run-riffle habitat situated in bedrock-boulder formation. This upper interrupted perennial reach is of virtually no value for consideration as a salmonid fishery.

Benthos was collected on two periods of sampling, July 27, 1976 and June 15, 1977 at Stations I and VIII respectively. Campbell Blue Creek exhibited the most diverse benthic fauna of all streams surveyed during this study, with nine orders and twenty-eight families represented, Table 23. Stream morphology provided a variety of pool and riffle habitats over sand, gravel, and boulder substrates. Qualitative data collected in this study infer this system is capable of supporting a sufficiently expanded fishery resource of habitat conditions were comparable for the population expansion.

Table 23 - Taxonomic List of Invertebrates Collected from Campbell Blue Creek, Stations I and VIII, 28 July 1976 and 15 June 1977 Respectively.

Taxon	Taxon
Ephemeroptera	Coleoptera
Baetidae	Dryopidae
Heptageniidae	Staphylinidae
Tricorythidae	Dytiscidae
Trichoptera	Hydrophilidae
Hydropsychidae	Hemiptera
Hydroptilidae	Belostomatidae
Glossosomatidae	Naucoridae
Helicopsychidae	Veliidae
Limnephilidae	Corixidae
Psychomyiidae	Odonata
Diptera	Aeshnidae
Tendipedidae (=Chironomidae)	Agrionidae
Simuliidae	Gastropoda
Heleidae (=Ceratopogonidae)	Physidae
Stratiomyidae.	Acari
Tabanidae	Parasitengona
	Oribatei
	Oligochaeta


R3
R31E
T5N
T41/2N
R30E
R31E
SK3.69
IV
SK2.51
III
MATCH
FIGURE
VIII
Cat Creek
KE Canyon
Turkey Creek
SK1.67
II
Arizona
New Mexico
VI
IV
I
MATCH
FIGURE VII
V
III
SK0.00
T41/2N
T4N
I
II
SK0.00
SK0.00
R31E
R32E
SK0.90
II
III
SK0.44
IV
N
Buckalou Creek
Castle Creek
0 1 2
Mi.
Km.
0 1 2 3
① Sampling Station
~ Perennial Flow
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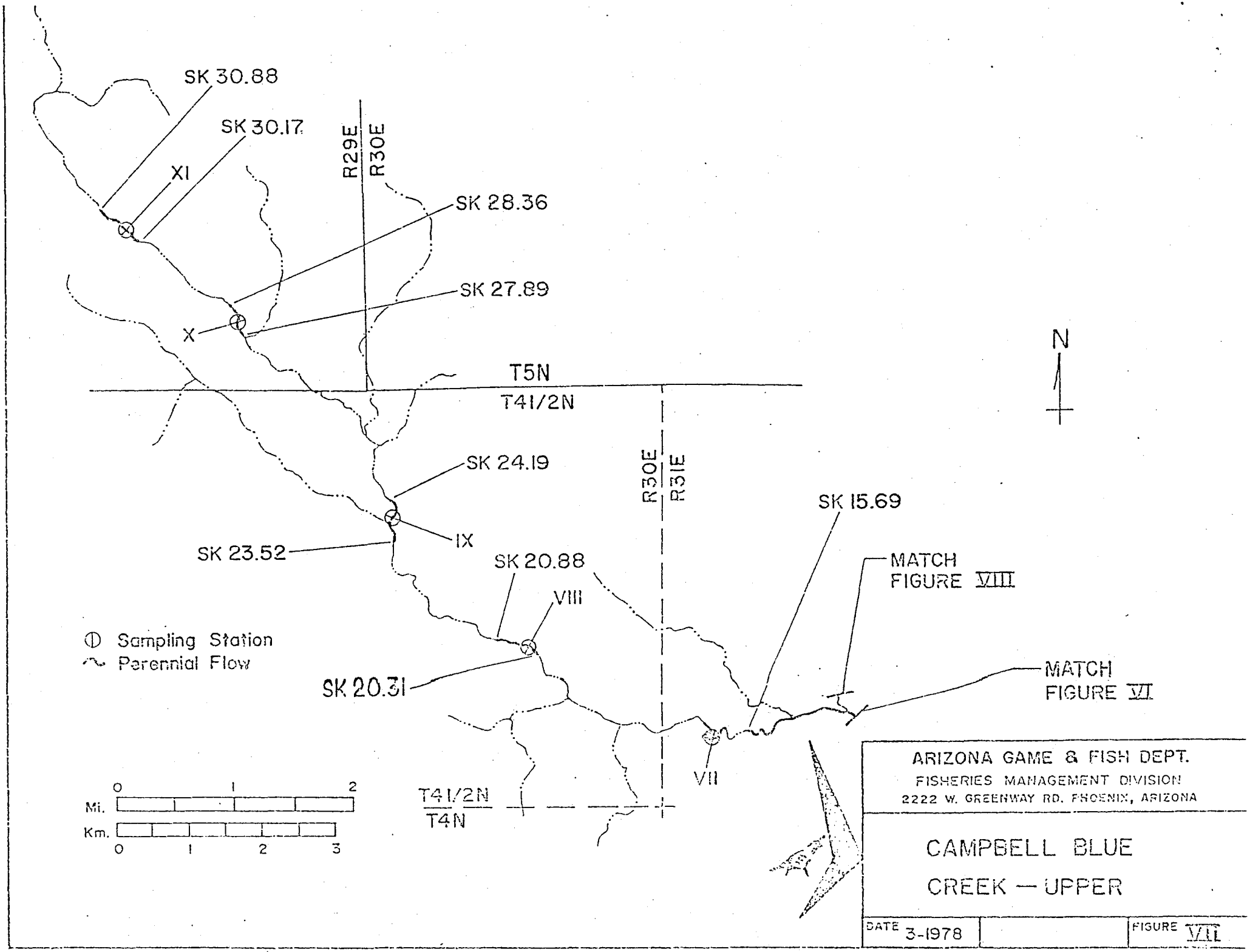
CAMPBELL BLUE
CREEK — LOWER
DATE 3-1978
FIGURE VI



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CAMPBELL BLUE CREEK — UPPER

DATE 3-1978

FIGURE VII

Campbell Blue Creek exhibited the greatest diversity of fish fauna collected from a tributary stream during this study with six species represented in the collections, Table 24. Previous to this survey a single collection had been recorded from the system, on September 2, 1964 speckled dace, Rhinichthys osculus were collected at or near Station VII of this study (ASU 1339). Stocking records of the Arizona Game and Fish Department indicate the system has provided an exotic salmonid fishery since at least 1933 (Anon.,1933), with brown, rainbow, "native" cutthroat trouts and grayling all having been stocked since that time. Collections during this study reveal only the brown trout, S. trutta remaining to provide for this recreation. Considering elevated temperatures recorded during the study, this observation could be anticipated as the species is more tolerant of the conditions prevalent in Campbell Blue Creek. Size structure of voucher specimens indicate a viable population exists with four to five age groups represented in the collections.

The remaining fish fauna of the system is comprised of native cyprinid and catostomid species. The longfin dace, Agosia chrysogaster is abundantly distributed throughout the lower reach from confluence to at least Station IV. Size structure reveals three to four year classes indicating viability of the population. Speckled dace, Rhinichthys osculus is the most abundant species present and is distributed throughout the system, being the only species above Station VII. Size structure reveals three to four year classes, indicative of a viable population. Loach minnow, Tiaroga cobitis is the third native cyprinid collected in Campbell Blue Creek with two specimens recorded, one each at Stations I and IV. This collection represents only the third recording of the species from the Blue River drainage (ref. Blue River section preceeding). No inference can be made concerning population levels or structure for the species from this collection, however, voucher specimens were of two distinct sizes indicating at least marginal viability. The Gila sucker, Catostomus insignis was collected in pool habitats throughout the lower reach from Station I to Station VI with the exception of Station V. Size structure of specimens retained infers a viable population with three to four year classes represented. The remaining species collected Gila mountain-sucker, Pantosteus clarki was taken in riffle and pool headwater habitats in and below Station VI excepting Stations IV and V. Size class structure reveals a viable population of this species with four to five year classes represented.

Physical condition of Campbell Blue Creek dictates that management objectives be directed toward maintenance of the brown trout, S. trutta fishery. Construction of physical enhancement features may be economically impractical considering watershed size and discharge potential, however, efforts should be expended toward enhancing the natural succession capabilities of the riparian community throughout the lower reach below Station V.

Periodic surveys should be undertaken to monitor distribution and structure of the loach minnow, T. cobitis population to document trends of this unique cyprinid.

Table 24 - Campbell Blue Fish Collections. Size Range (SL mm) in Parentheses Unless Otherwise Noted.

SPECIES	STATION										
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Longfin dace, *Agosia chrysogaster*	39 (36-72)	56 (37-69	3 (56-58)	8 (31-42)	--	--	--	--	--	--	---
Speckled dace, *Rhinichthys osculus*	30 (37-68)	46 (39-74)	12 (40-56)	35 (32-57)	3 (40-56)	--	10 (34-51)	42 (27-60)	12 (29-49)	5 (27-50)	9 (36-63)
Loach minnow, *Tiaroga cobitis*	1 (23) ASU6961	--	--	1 (51) ASU6974	--	--	--	--	--	--	--
Gila sucker, *Catostomus insignis*	5 (60-125)	8 (60-143)	3 (71-205)	1 (176)	--	1 (213)	--	--	--	--	--
Gila Mt. sucker *Pantosteus clarki*	9 (26-144)	5 (40-66)	3 (71-205)	--	--	4 (161-176)	--	--	--	--	--
Brown trout, *Salmo trutta*	--	--	2 (57-171)	--	5 (94-216)	4 (49-180)	1* (330)	--	--	--	--

*Denotes specimen returned live to station and total length (TLmm)

Turkey Creek

Turkey Creek is a 7.44 kilometer (4.62 mile) south-flowing interrupted perennial tributary of Campbell Blue Creek, confluence SK 0.00 is located in SW¼SE¼NE¼, Section 31, T4½NR32E approximately three kilometers upstream of the Arizona-New Mexico boundary. Drainage area of the system is 13.70^2 kilometers (5.29^2 miles) ranging in elevation from 1998 meters (6550 ft.) at confluence to a maximum 2776 meters (9100 ft.). Mean gradient of the system is 104.6 meters/kilometer (551.9 ft./mile) over the stream course.

Turkey Creek was surveyed on June 15, 1977, four sampling stations were established within the system, Table 25. Perennial flow was restricted to two discrete reaches totaling 2.85 kilometers (1.77 miles) Figure VI. Surface discharge calculated for Station II in the lower reach was 1.05 L/sec.(16.7 gpm) this figure presumably represents minimum flow for the stream due to season of year and the occurrence of abnormally low precipitation during the water year. Surface flow in the upper reach originates from a spring source located at Station IV, SK 3.69 (sm 2.29) discharge at this locality was calculated to be 2.21 L/sec. (35.0 gpm). Thermally, Turkey Creek was marginal for salmonid fisheries at time of survey except at spring source in the upper reach with temperatures recorded for Station II, III and the spring source being 21.5^o C (70.7^o F), 21^o C (69.8^o F) and 15.5^o C (59.9^o F) respectively. Chemical parameters recorded at Station II were: oxygen, 6.0 ppm, pH, 9.2.

Table 25 - Turkey Creek Sampling Station Locations, June 15, 1977.

Station I-----SE¼SW¼NE¼, Sec. 31, T4½NR32E; SK 0.11 (sm 0.07)
Station II----NW¼SE¼SE¼, Sec. 30, T4½NR32E; SK 1.16 (sm 0.72)
Station III---NE¼NE¼NW¼, Sec. 30, T4½NR32E; SK 2.75 (sm 1.71)
Station IV----NE¼NW¼SW¼, Sec. 19, T4½NR32E: SK 3.69 (sm 2.29)

A single barrier site was located within the system during survey. At Station III, SK 2.75 (sm 1.71) bedrock formation traverses the stream course and flow passes through a chute and falls approximately one meter. This site segregates the upper perennial reach of Turkey Creek from the lower system, construction of a barrier at this location would create approximately one kilometer of isolated habitat. Turkey Creek has undergone severe scouring from confluence with Campbell Blue Creek to Station III, and fishery habitat was virtually non-existant at time of survey. The entire reach was composed of shallow run over gravel substrate, pool habitat was virtually absent. Overstory vegetation was near non-existant adjacent the stream course and only marginal re-growth was evident. The upper reach, above barrier site, has not undergone the scouring evident in the lower reach, yet adequate pool habitat is lacking and additional improvement will be necessary to provide cover and volume indices requisite for development of a fishery.

Turkey Creek supported no fish life at time of survey and review of former records for the area indicate no previous collection having been made within this system. However, the faunal base undoubtedly underwent drastic decline and apparent total elimination of fish fauna as a result of flood and scouring prior to this study. No barrier exists in the lower 2.75 kilometer reach that would preclude fish movements to and from Campbell Blue Creek, cyprinid and catostomid fishes should have occurred in the system during pre-flood times. Assuming no further scouring, natural succession of the stream course and regrowth of the associated vegetative complex should occur thus reverting the system to former condition. This projected recovery may eventually result in the return of native fishes to the stream.

Benthic faunal diversity in Turkey Creek revealed a relatively high index with six orders and fourteen families represented in the collection, Table 26. Sampling was conducted at Station II in the lower reach, elevation ca. 2024 meters (6640 ft.)Collections were made in both run and riffle habitats, substrate was gravel and sand. No pool community habitat is present in this reach, consequently additional diversity of the invertebrate faunal base could be expected above that observed during this study if the system displays succession and development of the pool type.

Table 26 - Taxonomic List of Invertebrates Collected from Turkey Creek, June 15, 1977.

Taxon	Taxon
Ephemeroptera	Colepotera
Leptophlebiidae	Dytiscidae
Baetidae	Dryopidae
Heptageniidae	Odonata
Trichoptera	Aeshnidae
Limnephilidae	Hemiptera
Helicopsychidae	Belostomatidae
Hydroptilidae	
Glossosomatidae	
Diptera	
Tendipedidae (=Chironomidae)	
Simuliidae	
Heleidae (=Ceratopogonidae)	

Turkey Creek above Station III is marginal habitat to support establishment of a minor brown trout, S. trutta fishery at conditions observed during this investigation.

Improvement structures are required to enhance volume indices requisite to attain optimum potential of the system. Considering the small amount of habitat available, Turkey Creek should only be considered low priority for development expenditures.

K-E (Creek) Canyon

K-E Canyon, Figure VI is a 3.83 kilometer (2.38 mile) south-flowing ephemeral tributary of Campbell Blue Creek. Confluence SK 0.00 is located in SW¼NE¼NW¼, Sec. 36, T4½NR31E (unsur). Drainage area of the system is 4.17 km^2 kilometers (1.61 mi^2 miles) ranging in elevation from 2027 meters (6650 ft.) at confluence to a maximum over 2731 meters (8960 ft.) Mean gradient of the system is 183.8 meters/kilometer (970.6 ft./mile) over the stream course.

K-E Canyon was surveyed on July 27, 1976, no permanent stations were established as the system is ephemeral in character and flow present at time of survey was totally constributed by local occurring precipitation, no spring sources were located.

Three barriers were located within the stream course during survey. At SK 1.00 (sm 0.62) a series of three 1.5 to 2.0 meter vertical drops is present at SK 1.61 (sm 1.00) and SK 2.11 (sm 1.31) drops of 2.0 and 1.5 meters respectively exist. Their presence, however, is of no value as habitat is totally absent within the system to support a fishery.

K-E Canyon supports no fish life and the invertebrate faunal base is totally terrestrial in origin. This system warrants no consideration for future fishery investigation.

Cat Creek

Cat Creek, Figure VI, is a 4.52 kilometer (2.81 mile) south-flowing ephemeral tributary of Campbell Blue Creek. Confluence(SK 0.00) is located in SW¼SE¼NW¼, Section 35, T.4½N.R31E (unsur.) Drainage area of the system is 4.84 km^2 kilometers (1.87 mi^2 miles), ranging in elevation from 2059 meters (6750 ft.) at confluence to a maximum 2741 meters (8987 ft.). Mean gradient of the system is 150.9 meters/kilometers(796.1 ft./mile) over the stream course.

Cat Creek was surveyed on July 29, 1976, like K-E Canyon, no permanent stations were established in the system due to the ephemeral character of the stream; and flow present at time of survey was attributed to local occurring precipitation. A single spring source was located in the system at SK 2.37 (sm 1.47), however, the discharge of this source provides no appreciable flow to the stream and supports only a minimal aquatic seep complex of approximately four square meters.

Two barriers were located within the stream course, at SK 0.85 (sm 0.53) and at SK 1.67 (sm 1.04) vertical drops of 1.5 meters and 3.0 meters respectively exist. However, their presence is of no value as fishery habitat is totally lacking within the system.

No fish life exists in Cat Creek and exclusive of the spring source complex, the invertebrate fauna of this system is totally terrestrial in origin. Consequently, Cat Creek warrants no further investigative efforts toward establishment of a fishery resource.

Buckalou Creek

Buckalou Creek is a 3.52 kilometer (2.19 mile) north-flowing perennial tributary of Castle Creek that constributed the entire flow of Castle Creek at time of survey. Confluence (SK 0.00) is located in NE¼NE¼NE¼, Section 5, T4NR31E,(unsur), 2.04 kilometers (1.27 miles) above the confluence of Castle and Campbell Blue creeks. Drainage area of the system is 3.26^2 kilometers (1.26^2 miles), ranging in elevation from 2185 meters (7170 feet) at confluence to a maximum over 2512 meters (8240 feet). Mean gradient of the system is 92.9 meters/kilometer (488.6 ft./mile) over the stream course.

Buckalou Creek was surveyed on June 16, and August 17, 18, 1977, four sampling stations were established within the system at that time, Table 27. This system had perennial flow from its confluence with Castle Creek to SK 0.90 (sm 0.56), Figure VI the remaining headwater reach was ephemeral in character at time of survey with only minimal water present. Flow of the system originates from a multi-source spring aquafer located throughout stream reach SK 0.58-SK 0.90. Discharge calculated for Station I was 24.6L/Sec. (390 gpm). Thermal quality of the system is conducive for salmonid fisheries with temperatures of 15.5°C (59.9°F) and 19°C (66.2°F) observed at Stations I and II respectively. Chemical parameters recorded for Station II were: oxygen, 9.0 ppm; pH 8.0.

Table 27 - Buckalou Creek Sampling Station Locations, June 16, August 17, 18, 1977

Station I----	SE¼NE¼NE¼, Section 5, T4NR31E(unsur); SK 0.00 (sm 0.00)
Station II---	NE¼SE¼NE¼, Section 5, T4NR31E(unsur); SK 0.44 (sm 0.27)
Station III--	SW¼SE¼NE¼, Section 5, T4NR31E(unsur); SK 0.72 (sm 0.45)
Station IV---	SW¼NW¼SE¼, Section 5, T4NR31E(unsur); SK 1.14 (sm 0.71)

Buckalou Creek has an effective barrier located at approximately the midpoint in the perennial reach of the system SK 0.44 (sm 0.27).

This barrier was estimated to be a vertical drop of ca. 9 meters (30 feet). Other barriers were found in the ephemeral headwater reach of the system, however, are of no value due to absence of perennial flow. Above the barrier only marginal habitat exists as the reach is dominated by run type habitat over a bedrock substrate, consequently this reach is of little value for fishery consideration under conditions observed. Below the barrier abundant habitat is available providing a substantial fishery resource, this reach could be enhanced through installation of improvement structures.

Two sampling periods and station locations were involved in the Buckalou Creek benthic collections. Eight orders and twenty-three families comprise the taxa collected during this survey, Table 28. Station II was located below the barrier and contained pool and riffle habitats that were sampled over sand, gravel and boulder substrates. Station III was located above the barrier and contained marginal pool and run habitats over a bedrock substrate.

Table 28 - Taxonomic List of Invertebrates Collected from Buckalou Creek, Stations II and III, August 17, and June 16, Respectively.

Taxon	Taxon
Ephemeroptera	Coleoptera
Siphlonuridae	Dytiscidae
Baetidae	Elmidae
Heptageniidae	Odonata
Trichoptera	Aeshnidae
Limnephilidae	Gomphidae
Leptoceridae	Agrionidae
Hydropsychidae	Hemiptera
Glossosomatidae	Veliidae
Hydroptilidae	Hirudinea
Psychomyiidae	Gordiida
Diptera	
Tendipedidae (=Chironomidae)	
Simuliidae	
Heleidae (=Ceratopogonidae)	
Tipulidae	
Stratiomyidae	
Culicidae	

The fishery of Buckalou Creek is comprised of a single species population of hybrid trout, Salmo apache x S. gairdneri.

This finding represents only the second known collection record of S. apache from a naturally occurring population in the Blue River drainage. The one previous collection was taken from K.P. Creek on August 25, 1914 and consisted of 4 specimens, 154-200 mm, CAS 27152 (Miller, 1950, 1972), as with collections made during this study, they were hybrid specimens.

This population is confined to the lower stream reach from confluence to the barrier SK 0.44. Size structure of voucher specimens retained, Table 29, indicate a vaiable population with at least four year classes represented. Larger specimens within the population are found in Station II, the plunge pool at barrier base and immediately below, while smaller individuals are apparently displaced downstream throughout the system to confluence as represented by Station I collections immediately above confluence.

Collections made below the confluence in Castle Creek yielded only Brown trout, S. trutta. This population apparently restricts the hybrid population to the Buckalou Creek system presumably through predation on the younger year classes in the confluence area of Buckalou-Castle Creeks. No apparent reason exists for the exclusion of brown trout from Buckalou-Creek and an eventual migration of the more competitive species should be anticipated with a resultant decline in the unique hybrid population.

Table 29 - Buckalou Creek Fish Collections, June 16, and August 17,18,1977. Size Range (SL mm) in Parentheses.

Species	Station I	Station II	Station III	Station IV
Hybrid trout S. apache x S. gairdneri	10 (53-120) ASU7385	9 (110-193) ASU7451	--	--

Buckalou Creek supports a unique hybrid trout fishery, of scientific interest, under conditions observed during this investigation. However, feasibility of enhancing this resource significantly is minimal as little habitat is available. Improvement structures installed in the confluence to barrier reach would benefit the population by increasing volume indices requisite for production of larger size class individuals and numbers. Additional consideration could be given to improving the 0.46 kilometer headwater reach above barrier and subsequent introduction, to expand the population above its present range.

This alternative, if successful, would preclude elimination of the population by competition with brown trout, S.trutta, as no barrier construction site is present in the lowermost reach of the system.

Coleman Creek

Coleman Creek is a 13.44 kilometer (8.35 mile) south-easterly flowing tributary of Campbell Blue Creek. Confluence SK 0.00 is located in SW¼NW¼NE¼, Section 32, T4½NR31E(unsur). Drainage area of the system is 47.81^2 kilometers (18.46^2 miles) ranging in elevation from 2165 meters (7100 ft.) at confluence to a maximum 2855 meters (9360 ft.). Mean Gradient of the system is 47.5 meters/kilometer (251.5 ft./mile) over the stream course.

Coleman Creek was surveyed on August 17, 1977, five sampling stations were established at that time, Table 30. The system had perennial flow from confluence with Campbell Blue Creek to SK 6.74 (sm 4.19), above this location the stream was ephemeral in character, Figure VIII. Discharges calculated for Station I, II, III and IV were 0.049^3 meters/second (1.69 cfs), 1.59L/second (25.2 gpm), 2.89 L/second (45.8 gpm) and 4.22 L/second (66.9 gpm) respectively at time of survey. Thermally the system exhibits qualities conducive for salmonid fisheries with temperatures recorded at Station I through V ranging from 20^o C (68^{o}F) at lowermost to 13^o C (55.4^o F) at uppermost Station V. Chemical parameters recorded at Station V were: oxygen, 9.0; pH, 7.0.

Table 30 - Coleman Creek Sampling Station Location, August 17, 1977.

Station I	SW¼NW¼NE¼,	Section 32, T4½NR31E (unsur);	SK 0.02 (sm 0.01)
Station II	NE¼SE¼SW¼,	Section 29, T4½NR31E (unsur);	SK 0.84 (sm 0.52)
Station III	NE¼SW¼SW¼,	Section 29, T4½NR31E (unsur);	SK 0.93 (sm 0.58)
Station IV	NE¼NW¼SW¼,	Section 19, T4½NR31E (unsur);	SK 4.35 (sm 2.70)
Station V	SE¼SE¼SE¼,	Section 13, T4½NR30E (unsur);	SK 5.55 (sm 3.45)

Coleman Creek was found to have an existing barrier located at SK 0.90 (sm 0.56) estimated vertical drop was 5.0 meters (16 ft.). The barrier isolates approximately five kilometers (three miles) of habitat having potential for establishment of a fishery. Both pool and riffle type habitat were abundant within the reach at time of survey consequently, no additional development would be required to enhance volume indices or cover. Benthic fauna was abundant throughout the reach and no fish were either collected or observed.

The uppermost perennial waters of Coleman Creek, above Station V, provide only minimal habitat, volume indices and cover are low throughout consequently, this reach is of little value for fishery consideration.

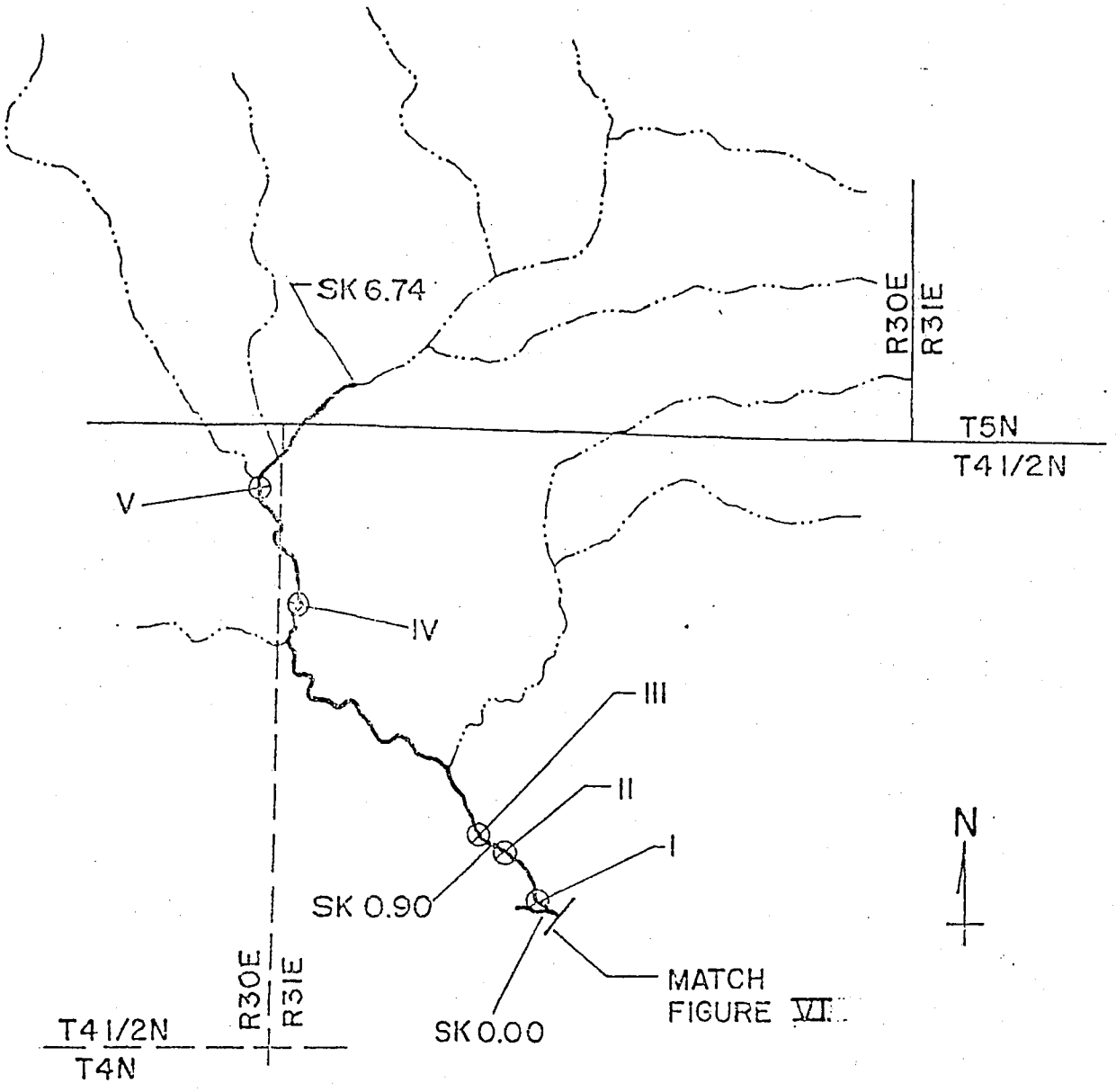
From confluence with campbell Blue Creek to barrier the system has abundant habitat of superior quality with both pool and riffle types well represented. A dense vegetative complex provides abundant cover and shade throughout the reach.

Coleman Creek benthic faunal collections contained the highest diversity of characteristic "trout food" organisms observed during this study with four ephemeropteran (mayfly), six trichopteran (caddisfly) and one plecopteran (stonefly) family represented, Table 31. This collection was made at Station V, elevation 2402 meters (7880 ft.), in both pool and riffle habitats over silt, gravel, and boulder substrates.

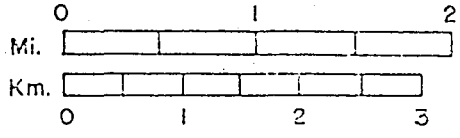
Table 31 - Taxonomic List of Invertebrates Collected From Coleman Creek, Station V, August 17, 1977.

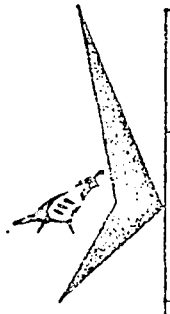
Taxon	Taxon
Ephemeroptera	Diptera
Siphlonuridae	Tendipedidae(=Chironomidae)
Baetidae	Simuliidae
Leptophlebiidae	Dixidae
Heptageniidae	Stratiomyidae
Trichoptera	Tipulidae
Hydropsychidae	Psychodidae
Glossosomatidae	Hemiptera
Helicopsychidae	Gerridae
Hydroptilidae	Corixidae
Leptoceridae	Hirudinea
Psychomyiidae	Oligochaeta
Plecoptera	Pelecypoda
Nemouridae	Spaeriidae
Coleoptera	
Elmidae	
Psephenidae	
Dytiscidae	

The existing Coleman Creek fishery is comprised of a single species population, brown trout, S. trutta restricted in distribution to the lowermost reach below barrier. Voucher specimens retained during this survey, Table 32, indicate a viable population with three distinct size classes represented. Smaller specimens of the population are dispersed within the lower section of the reach while larger individuals are dominate in the upper section.



① Sampling Station
~ Perennial Flow





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COLEMAN CREEK

DATE 3-1978

FIGURE VIII

This fishery undoubtedly represents a migrant extension of the Campbell Blue Creek fauna as no introduction of this species is recorded for the system. Formerly, Coleman Creek provided an exotic salmonid fishery with brook, and "native" trouts introduced during the period 1933-1938 (Anon. 1933-1938). Native trout referenced therein being the Wyoming cutthroat, then commonly introduced in the White Mountain region (pers. comm., H.M. Bassett, Arizona Game and Fish Department, 1977).

Table 32 - Coleman Creek Fish Collections, August 17, 1977
Size Range (SL mm) in Parentheses.

Species	Station I	II	III	IV	V
Brown trout, *Salmo trutta*	8 (66-206)	2 (162-192)	---	--	--

Coleman Creek presents an uncommon management opportunity for establishment of a substantial native salmonid fishery at little monetary expenditure. The system provides approximately five kilometers (three miles) of isolated stream potentially habitable by Arizona trout, *S. apache*. Introduction of *S. apache* above the barrier location could result in the establishment of an additional population of this unique endemic salmonid within its historic range. Management objectives for the lower 0.90 kilometer (0.56 mile) stream reach should be directed toward maintenance of the existing brown trout, *S. trutta* fishery. No additional improvement features are required to enhance the system for support of either population. Upon introduction of *S. apache* into the upper reach, subsequent surveys should be periodcally undertaken to monitor success of the introduction and to determine population structure and viability.

Pace-Jackson Creeks

The Pace-Jackson Creek complex encompasses two minor contiguous systems totaling 36.52^2 kilometers (14.10^2 miles) of drainage area overlaying the Arizona-New Mexico boundary. The system is a southeasterly flowing tributary of Dry Blue Creek with confluence located at 3.65 kilometers (2.27 miles) inside New Mexico.

Pace Creek the major perennial unit of this drainage is 9.69 kilometers (6.02 miles) in length with drainage area of 20.25^2 kilometers (7.82^2 miles) However, only 7.46^2 kilometers (2.88^2 miles) lie in Arizona. Elevation varies from 2012 meters (6600 feet) at confluence in New Mexico to 2493 meters (8178 feet). Mean gradient of the system is 41.5 meters/kilometers (318.9 feet/mile) over the stream course.

Pace Creek was surveyed on August 16, 1977, two sampling stations were established at that time, Table 33. The system had perennial flow from the Arizona-New Mexico boundary (SK 0.00) to SK 3.42 (sm 2.13) additionally the lowermost 0.10 kilometer reach of the east branch was perennial, Figure IX. Discharges calculated for Stations I and II were 6.80 L/sec. (107.8 gpm) and 3.11 L/sec. (49.3 gpm) respectively. Flow within both branches of Pace Creek permeates from meadow alluvial fill in the headwater reach. Thermally, Pace Creek was marginally adequate for salmonid fisheries with temperature recorded at Station II being 19 ^{o}C (66.2^{o} F) at time of survey. Chemical parameters for the same locality infer non-suitability of the system for fishery consideration with oxygen of 4.0 ppm and pH of 7.0 recorded during investigation.

Table 33 - Pace-Jackson Creek Sampling Station Locations, August 16, 1977

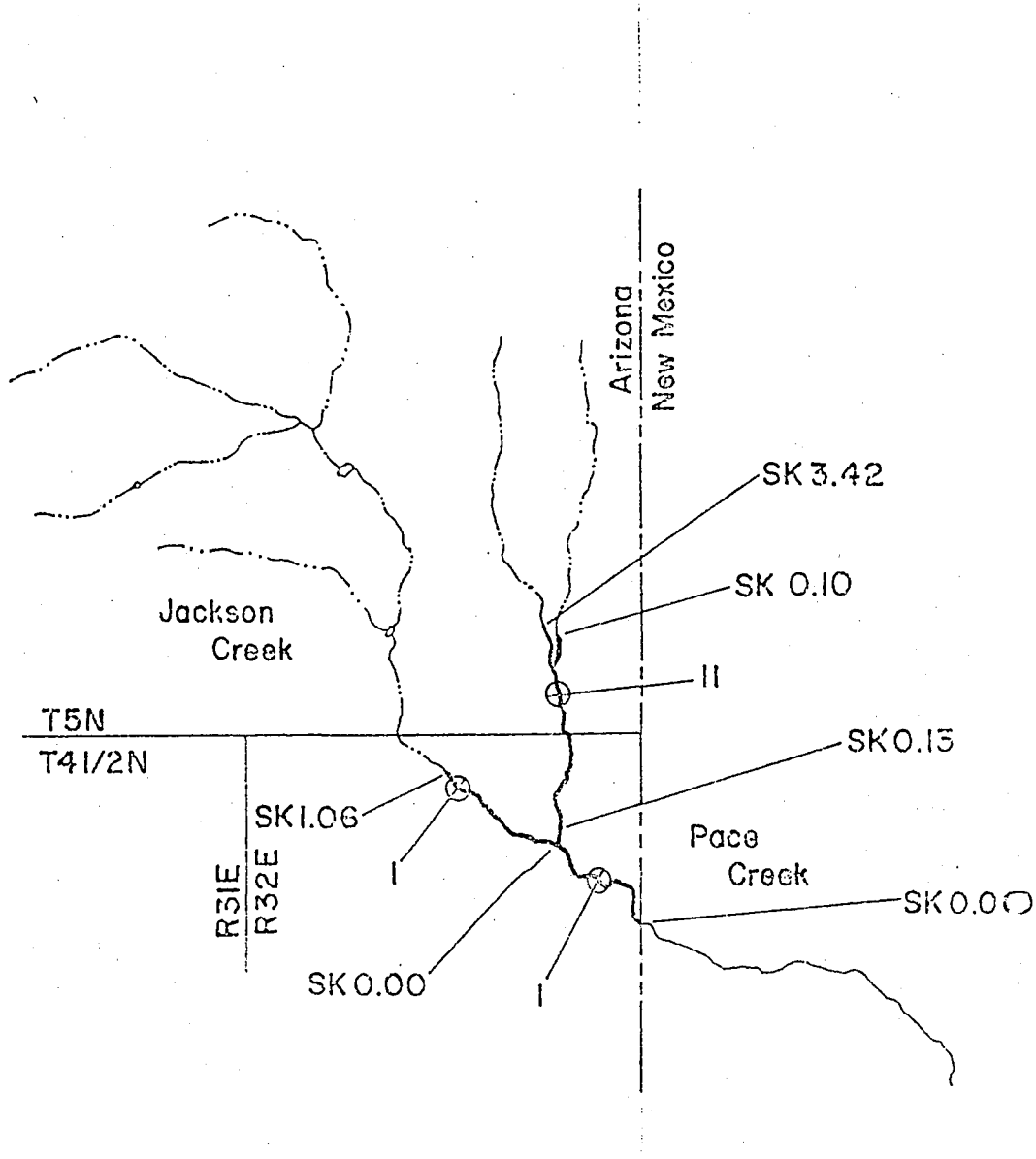
Pace Creek

Station I----SW¼SE¼NE¼, Section 20, T4½NR32E; SK 0.71 (sm 0.44)
Station II---NW¼SW¼SW¼, Section 35, T5NR31E; SK 2.72 (sm 1.69)

Jackson Creek

Station I----NE¼NW¼SW¼, Section 17, T4½NR32E; SK 1.00 (sm 0.62)

Jackson Creek is a 8.35 kilometer (5.19 mile) southeasterly flowing tributary of this system, confluence with Pace Creek SK 0.00 is located in SW¼NW¼NE¼, Section 20, T4½NR32E. Drainage area of the Jackson Creek sub-unit is 16.27^2 kilometers (6.28^2 miles) ranging in elevation from 2242 meters (7355 feet) at confluence to a maximum 2853 meters (9360 feet). Mean gradient of the system is 26.5 meters/kilometers (139.7 feet/mile) over the stream course.



① Sampling Station
~ Perennial Flow

N

0 1 2
Mi.
Km.
0 1 2 3

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PACE — JACKSON CREEKS

DATE 3-1978

FIGURE IX

Jackson Creek was also surveyed on August 16, 1977 with only a single station being established, Table 33. The system had perennial flow from confluence with Pace Creek to SK 1.06 (sm 0.66). Like Pace Creek flow originates from alluvial fill, in this instance, in the lower meadow reach of the system. Discharge calculated for the station was 3.11 L/sec. (49.3 gpm) at time of survey. Temperature recorded at this locality was 21°C (69.8 °F), chemical parameters of oxygen and pH were 8.0 ppm and 7.2 respectively, as with Pace Creek these data infer only marginal suitability for salmonid fisheries.

No barrier exists in the perennial reach of Jackson Creek, however, two were located within the Pace Creek stream course. At SK 0.13 and immediately above Station II SK 2.72 vertical drops of approximately two meters (nine feet) occur where the stream traverses bedrock formation. Habitat throughout the perennial reach of each system is of low value for fishery consideration as pool indices are marginal with each stream dominated by run-riffle type habitat. Substrates display evidence of excessive fines presumably originating from the deeply incised alluvium where the stream course traverses meadow areas.

Neither Pace nor Jackson Creeks supported fish fauna at time of survey and records indicate no former collections having been made in either drainage. This observation implies an isolation of the system from Dry Blue Creek in New Mexico presumably due to either an ephermeral reach or an additional effective barrier in the lowermost New Mexico portion of the stream course.

Benthic faunal diversity was relatively high in the Pace-Jackson Creek system with seven orders and thirteen families represented in the collection, Table 34. Sampling was conducted at Station I in the Jackson Creek reach of the system, habitat was pool-riffle type with abundant submergent and emergent rooted vegetation. The collection obtained the only amphipod recorded during this investigation.

Table 34 - Taxonomic List of Invertebrates Collected from Jackson Creek, Station I - August 16, 1977.

Taxon	Taxon
Ephemeroptera	Coleoptera
Baetidae	Dryopidae
Leptophelebiidae	Hemiptera
Trichoptera	Belostomatidae
Hydropsychidae	Gerridae
Helicopsychidae	Corixidae
Lemnephilidae	Gastropoda
Diptera	Physidae
Tendipedidae (=Chironomidae)	Amphipoda
Stratiomyidae	Talitridae

The Pace-Jackson Creek system provides minimal opportuni ty for fishery establishement at conditions observed during this inv esti-gation. Future surveys could be undertaken to substantiate c ondi-tions observed or note changes in habitat quality toward condi tions favorable for fishery introduction.

Mineral Creek

Mineral Creek is a 41.73 kilometer (25.93 mile) north-fl owing tributary of the "Concho Sink" with terminus in Little Ortega Lake. Study area of the system was confined to the headwater reach lying on National Forest Land. Drai nage are of this component of Mineral Creek is 33.34^2 kilometers (12.87^2 miles), ranging in elevati on from 2304 meters (7560 feet) at forest boundary, SK 0.00, to a max imum 3089 meters (10133 feet) on Greens Peak. Mean gradient of th e study reach is 32.87 meters/kilometer (173.59 ft./mile) on the main branch while the 2.36 kilometer (1.47 mile) "west fork" descends at a rate of 56.78 meters/kilometer (299.32 ft./mile).

Mineral Creek was surveyed on September 6-7, 1976, eight sampling stations were established on those dates, Table 35 . Perennia l flow of the lower system was contri buted totally by discharge of the "west fork" , originating from a mul ti-spring aquafer located at SK 7.08 (sm 4.40). A single isolated perennial reach was present on the main branch above confluence with "west fork" at time of survey at Station VIII. This unit of the system was a 0.82 kilometer (0.51 mil e) meander-ing seep through meadow alluvi um. Both above and below this reach the main branch of the system was ephermeral in character with no evidence of perennial water, Figure X . Dishcarge calculated for Sta tion IV was 0.05^3 meters/second (1.76 cfs.) at time of survey. Miner al Creek was thermally adequate for salmonid fisheries during investiga tion with temperature recorded at Station IV being 12^{o}C (53.6^{o} F). Che mical parameters recorded for the same locality were: oxygen, 10 p pm, pH, 9.0.

Table 35-Mineral Creek Sampling Station Locations, September 6-7, 1976

Station I----	SE¼SW¼NW¼,	Section 6, T9NR26E;	SK 0.72 (sm 0.45), Sept.7, 1976
Station II---	NW¼NE¼NW¼,	Section 7, T9NR26E;	SK 1.93 (sm 1.20), Sept.7, 1976
Station III--	NW¼NE¼SE¼,	Section 7, T9NR26E;	SK 3.14 (sm 1.95), Sept.7, 1976
Station IV---	SE¼SE¼SE¼,	Section 7, T9NR26E;	SK 3.94 (sm 2.45), Sept.7, 1976
Station V----	NE¼SW¼NW¼,	Section 17,T9NR26E;	SK 4.72 (sm 2.93), Sept.7, 1976
Station VI---	SW¼NE¼SW¼,	Section 17,T9NR26E;	SK 5.44 (sm 3.38), Sept.7, 1976
Station VII--	NE¼SE¼NW¼,	Section 20,T9NR26E;	SK 6.52 (sm 4.05), Sept.7, 1976
Station VIII-	NE¼NW¼NW¼,	Section 28,T9NR26E;	SK 8.45 (sm 5.25), Sept.6, 1976

No barrier was found in Mineral Creek nor were sites located within the study reach feasible for construction of a barrier. However, fish collections infer isolation of the system as neither exotic nor native species other than known introduced occurred in the study area. Stream terminus in "Concho Sink" precludes natural migration of fishes, thus only introduction could expand existing fauna. Distribution of fishes may be restricted in "west fork" to the reach below SK 5.20 as immediately above this locality a zone of high gradient traverses boulder formation and numerous 0.3-1.0 meter (1-3 ft.) vertical falls exist that possibly preclude upstream movement.

Habitat within Mineral Creek seemingly would provide for a substantial fishery as pool indices and cover are abundant throughout the perennial study reach from SK 0.00 to SK 5.98 (sm 3.72) on "west fork". However, spawning habitat a key element requisite for establishment of a self-sustaining fishery is virtually absent. The system displays evidence of excessive fines in substrate composition virtually throughout the study area. Consequently, the fishery may be depressed below potential capacity as a result of unsuccessful spawning. "East fork" provided no opportunity for fishery establishment as perennial flow was virtually absent throughout the reach above confluence of "west fork".

Benthic faunal diversity of Mineral Creek was relatively high considering fines present in the substrate at time of survey, Table 36. Habitat of the Station IV locality was pool-riffle type over silt, sand and gravel substrate. Characteristic "trout food" organisms were abundant in the collection with eight families represented. This data infers an adequate base to support an expanded fishery above that observed during investigation.

Table 36 - Taxonomic List of Invertebrates Collected from Mineral Creek, Station IV, September 7, 1976.

Taxon	Taxon
Ephemeoptera	Diptera
Baetidae	Tendipedidae (=Chironomidae)
Heptageniidae	Simuliidae
Plecoptera	Coleoptera
Chloroperlidae	Hydrophilidae
Trichoptera	Elmidae
Hydropsychidae	Oligochaeta
Hydroptilidae	Pelecypoda
Glossosomatidae	Sphaeriidae
Psychomyiidae	

No record of prior fish collection is known for Mineral Creek, presumably stream terminus in "Concho Sink" excluded native fauna and the system is thought to have been void of fishes until introduction by man.

Mineral Creek formerly provided an exotic salmonid fishery between 1937 and 1952 with brook, brown, and rainbow trouts introduced at various times during the period (Anon. 1937, 1941-52; Reid, 1942). Subsequently, no introductions were made until September 7, 1967 when following renovation 100 (4-11 inch) Arizona trout, Salmo apache were introduced above the Thompson Park road crossing. The following year, on October 14, 1968 an additional stocking of 300 (2.5-4 inch) S. apache was conducted at the same locality (Anon., 1967, 1968).

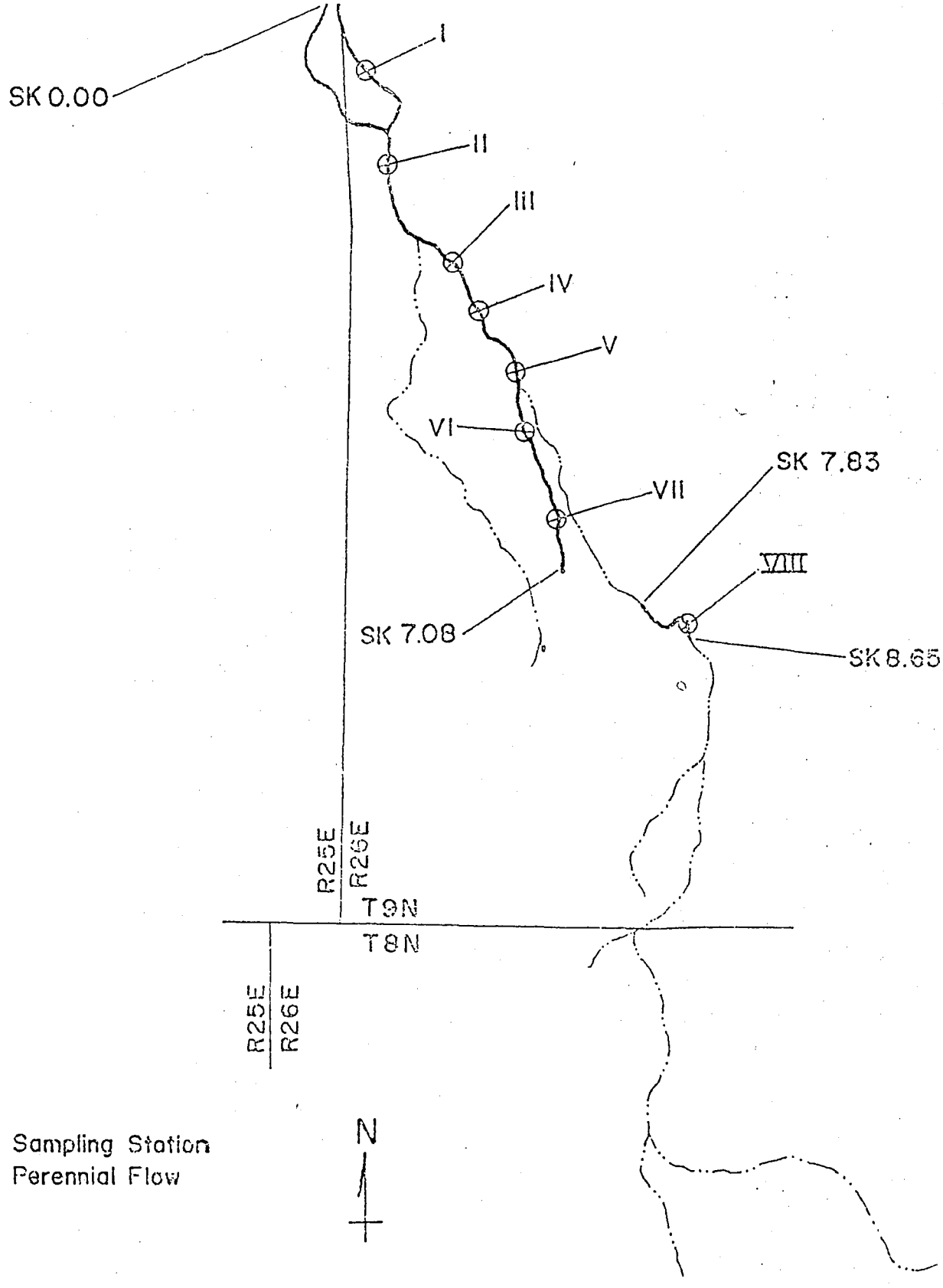
Collections made during this investigation indicate the population of Arizona trout remains at the present time, yet is restricted to the stream reach above Thompson Park road crossing in and near Station V of this study. No specimens were either collected or observed at other localities in the system. Size range of specimens obtained in Station V sampling infer little or no reproductive success of the population in recent years as no small size classes were represented, Table 37.

Table 37. Mineral Creek Fish Collections, September 7, 1976, Size Range (TLmm) in Parentheses.

Species	Station							
	I	II	III	IV	V	VI	VII	VIII
Arizona trout, Salmo apache	--	--	---	--	3* (174-206)	--	--	---

*Denotes specimens returned live to station.

Management of Mineral Creek should be oriented toward maintenance of the Arizona trout, S. apache fishery. Periodic surveys should be undertaken to verify observations of this study or to note improved habitat condition. In particular, these investigations should assess improvement in spawning substrate as this element appears inadequate to support a viable population of the species. Accompanying this study, a comprehensive water analyses should be conducted to determine if a toxic level of some component is precluding either successful spawning or population recruitment.



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MINERAL CREEK

DATE 3-1978

FIGURE

DISCUSSION

Of the eighteen systems inventoried during this investigation, seven (39%) were void of an existing fish fauna. Only two, however, lacked perennial flow (K-E Canyon and Cat Creek) and are of no potential for future fishery consideration. The remaining uninhabited five streams (Davis, Milk, Turkey, Pace and Jackson Creeks) exhibit potential for establishment of either game or non-game species. However, each would require stream improvement either naturally occurring or artificially created to achieve optimum potential.

Milk Creek provides habitat adequate to warrant attempted establishment of Arizona trout S. apache at conditions observed during this study. If successful a minor population of the species could be anticipated to occupy the 1.77 kilometer headwater reach. Upon establishment, construction of a barrier and improvement structures would further enhance composition and integrity of the population.

Davis and Turkey Creeks both exhibit potential for establishment of minor salmonid fisheries if improved prior to introduction. Davis Creek should be considered for Arizona trout, S. apache while brown trout, S. trutta would be more adaptive to the Turkey Creek system. Davis Creek requires physical installation of improvement structures in the headwater reach above the Stone Creek road crossing. Turkey Creek, however, will require both physical installations and enhancement of the riparian vegetative complex prior to introdcution.

Pace and Jackson Creeks represent systems of questionable value for salmonid consideration. These streams, however, do exhibit qualities adequate to support native cyprinid and catostomid species adaptive to low discharge systems. Consequently, being void of fishes these streams may be of value as research sites for studies in life history, and adaptation of native non-game species.

The eleven remaining systems surveyed during this investigation depict a varied composition of native and exotic fisheries of both natural and introduced origin.

Home, Mamie, and Mineral creeks are unique salmonid fisheries exclusively limited to Arizona trout, S. apache. Home Creek unlike the latter two streams apparently represents a naturally occurring population while Mamie and Mineral Creek populations are known to originate from introductions. Population levels within each of the systems are low with only Mamie Creek exhibiting recent reproductive success. Further analysis should be conducted for each stream to formulate specific concepts for maintenance and enhancement of these populations.

Buckalou and Hayground creeks represent additional salmonid fisheries of unique biological interest as each system supports a native-hybrid trout population. Further study of these streams may provide insight to the understanding of distribution, and interaction of exotic species with native salmonids. Hayground Creek may present opportunity for Arizona trout, S. apache restoration if an adequate barrier facility can be developed.

Strayhorse and Raspberry creeks are minor native non-game fisheries supporting populations of commonly occurring species excepting the sporadic occurrences of salmonid migrants from the Blue River. Neither system is adequate to support additional fauna either game or non-game.

Campbell Blue and Castle creeks are exotic salmonid fisheries dominated by brown trout, S. trutta. The former; however, also exhibits a markedly diverse native species fishery with a heretofore undocumented population of the loach minnow, T. cobitis. The lowermost eleven kilometer reach of Campbell Blue Creek is of low habitat quality and efforts should be conducted to enhance the riparian community associated with this reach.

Coleman Creek presents a unique opportunity for development of a discretely isolated two species salmonid fishery. The lowermost reach, below barrier, supports a moderately high brown trout, S. trutta population, however, above barrier the system is void of fishes. This headwater reach provides opportunity for establishment within historic range of an additional population of Arizona trout, S. apache at no significant expenditure.

Blue River is a diversified fishery of both native non-game and exotic salmonid species. The recreational fishery is composed of rainbow, S. gairdneri and brown, S. trutta trouts supported through annual plantings. The diverse native fauna (five species) is comprised of common cyprinid and catostomid fishes with exception of the unique loach minnow. T. cobitis. This population, like that of Campbell Blue Creek, was previously undocumented thus representing new distributional data for this species. Additional surveys should be conducted throughout this system to obtain further distributional data for the known fauna and determine if extent populations of other species occur.

This investigation represents the initial effort toward development of a comprehensive inventory of the aquatic habitats and fauna of Arizona. Parallel efforts are needed throughout the state to attain this ultimate objective. The study reported herein represents only a small portion of the effort required for an understanding of fish distribution on the Apache-Sitgreaves National Forest, yet alone statewide.

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